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FT food technology

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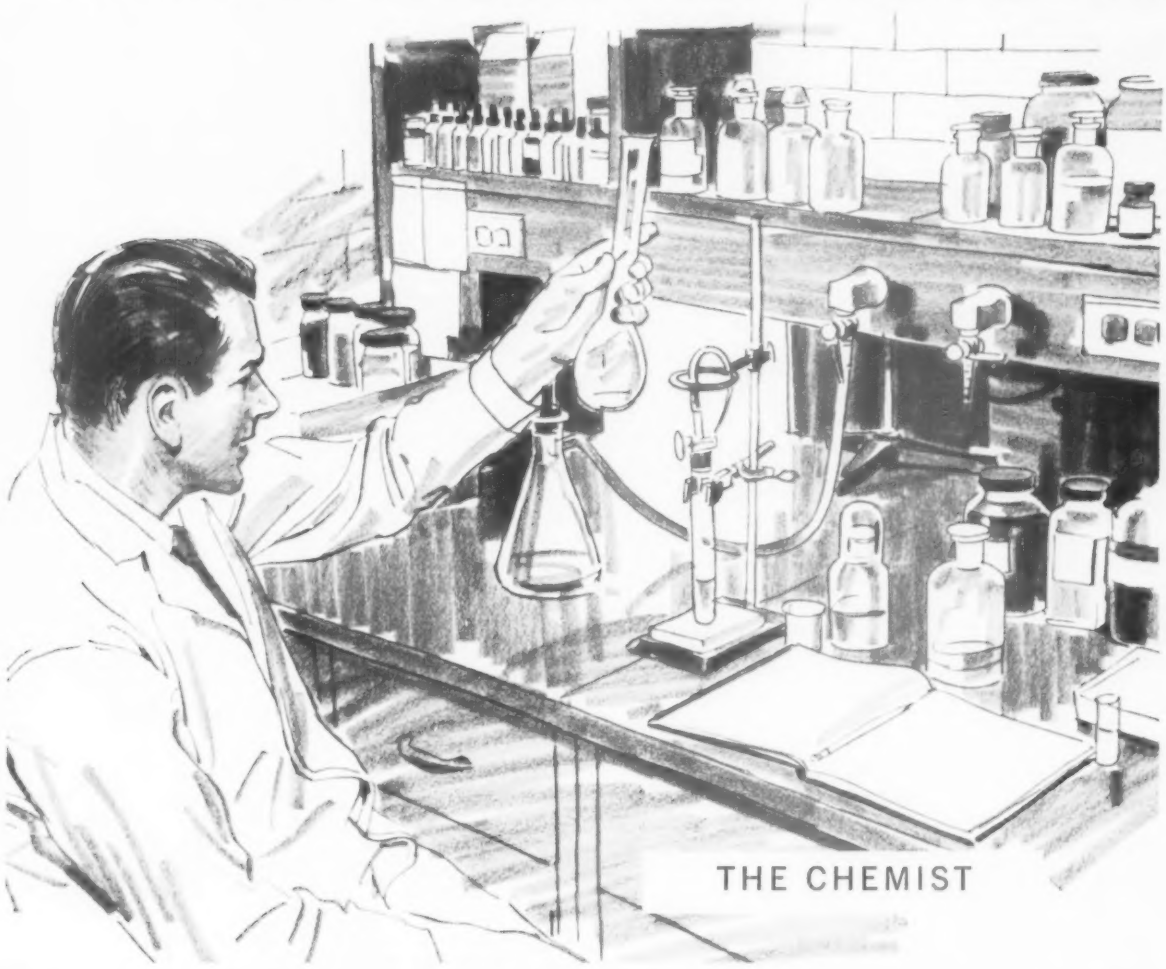

THE CHEMIST

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IN THIS ISSUE—

THE TECHNICAL ARTICLES IN BRIEF

Methodology *Estimating bacterial numbers on surface areas*

Approximation of surface areas of cut-up chicken and use in microbiological analysis. Harry E. Goresline and Raymond R. Haugh.

Growth of microorganisms on chicken meat is a surface phenomenon. This paper describes a method relating the numbers of microorganisms to the surface area by determining the surface area of chicken parts of very irregular dimensions using a semi-plastic wax. The wax was flowed on the pieces and after removal the surface area of the piece was determined. Each chicken part was weighed and the surface area of the piece plotted against the weight on graph paper. This was done on all parts of cut-up chicken of different weights so that the curves on the graphs represented the ratios of weight to surface areas for different weights of commercially produced cut-up chickens. From these curves a chart was constructed so that the surface area of a piece of chicken could be estimated from its known weight. This chart is used in making an estimation of bacterial numbers on the surface of chicken parts as related to the surface area. (See page 241.)

Reconstitution of dehydrates *Effect of treated water on acceptance*

The compatability of dehydrated army rations with chlorinated and iodine treated ground waters. Morris R. Rogers, Arthur M. Kaplan, and Elizabeth Pillion.

In providing subsistence for the soldier under field conditions the Quartermaster Corps relies heavily on dehydrated food. The compatibility of the purified (treated) water used in rehydration is therefore of interest. Four pre-cooked dehydrated foods were reconstituted with 5 sources of ground water exceeding the maximum levels of mineral concentration recommended by the U. S. Public Health Service Standards for Drinking Water. These waters were rendered potable by the addition of iodine or chlorine prior to use in the reconstitution of the dehydrated foods. The 3 screening foods were taste-odor-tested by a panel of 7 untrained members. The sensory panel, using the hedonic scale, scored both taste and odor. They recorded their comments on any marked differences in flavor and odor acceptability as well as the appearance of each reconstituted food. From the results, presented in terms of the mean hedonic scale ratings, it may be concluded that emergency use of iodine-treated and chlorinated-ground waters of the compositions tested impart no serious objectionable taste or odor to the precooked dehydrated foods tested; namely, hot cocoa, hot cream of onion soup, cold orange juice, tea (all made from powder bases). (See page 244.)

Grading *Fishery products*

The use of grade standards in the quality control of fishery products. M. E. Ambrose and M. Bender.

Certain characteristics of fish and shellfish are unique among foodstuffs and necessitate extra care in sanitation and handling if a quality product is to be produced. Prior to acceptance of a plant for continuous inspection by the U.S.D.I., a preliminary survey is made to determine the adequacy of the plant to produce a quality product. The layout of the plant is studied with respect to expeditious handling of materials from the raw stage to the finished product. The plant itself and its furnishings and equipment, as well as actual processing practices and cleaning operations must meet certain minimum sanitary requirements. Any physical deficiencies or unsanitary practices are to be remedied before the plant is accepted for continuous inspection. After the inspector is placed in a plant part of his duties are to see that sanitary conditions and practices are maintained. Although inspection for grade standards is always made on the finished product, the inspector is available for consultation and can suggest quality control measures during the processing of the product. When a standard is developed by the U.S.D.I., methods of grading and analysis are given in detail in the standard and may be used by any packer for his guidance in quality control. Many processors who have availed themselves of the inspection service have found that, in addition to the advantage of the "continuous inspection" or Grade label on their product, the inspector working in their plant has been an unofficial "trouble-shooter" helping them to raise the quality of their products. (See page 249.)

Food additive *Sodium sorbate*

Preservation of fruit products by sodium sorbate and mild heat. James F. Robinson and C. H. Hills.

A combination of sodium sorbate (0.05%) and mild heat (120° F. for 5 min.) greatly increased the storage life of fresh apple cider, peach slices, and fruit salad with no appreciable flavor change. In the presence of 0.05%

May Cover. Analyzing flavor is a complicated, exacting, but always challenging task. The cover picture for May (courtesy International Minerals and Chemical Corporation, Ac'cent International) shows a group of flavor analysts in action. Noting down their reactions to samples of canned corn, Ac'cent International flavor profile panelists are, left to right: Dr. Robert Good, senior research microbiologist; William Case, food technologist; Mrs. Ruth Miller, docket assistant; James Ryan, research chemist and panel leader, and Elizabeth Hoskins, research chemist. Mr. Case bends over his plate to get the full aroma of the corn. This is part of a shelf life study.

sodium sorbate, a heat treatment as mild as 100° F. for 5 minutes destroyed more than 50% of the initial yeasts, molds, and bacteria and increased the storage life to 14 days at room temperature. At 120° F. there was a 99% reduction in microbial counts and the storage life was increased to 25 days at 70° F. Similar results were obtained with the other fruit products. (See page 251.)

Quality evaluation — *Effect of growing area, ripeness, etc. on drained weight of canned apricots*

Drained weight of canned apricots. B. S. Luh, S. J. Leonard, and E. M. Mrak.

Various factors that may influence the drained weight and Brix readings of canned, unpeeled, Blenheim apricot halves were investigated These include growing area, storage time, cover syrup concentration, fill weight, and ripeness level. One day after canning, the drained weight was 84.1% of the fill weight because apricot fluid was lost to the cover syrup. On storage, drained weight increased rapidly for the first 5 to 10 days, and then slowly until an equilibrium drained weight was reached. For practical purposes, equilibrium drained weight may be considered to be reached 45 to 60 days after canning. Cover syrup concentration appeared to affect drained weight during the first few weeks after canning, but had only slight effect on equilibrium drained weight. Fill weight and ripeness level were important factors in influencing drained weight. Apricot halves canned in 40° Brix syrup with a fill weight of 19.5 oz. for each No. 2½ can at average pressure tests of 1.9, 1.3, and 1.0 lbs. gave an equilibrium weight retention of 97.1, 93.2, and 90.7%, respectively. (See page 253.)

Blanching — *Green beans for freezing*

Time-temperature tolerance of frozen foods. XVIII. Effect of blanching on color stability of frozen green beans. W. C. Dietrich, R. L. Olson, Marvel-Dare Nutting, and H. J. Neumann.

Observations of commercially packed frozen green beans indicated variation in color quality was related to conditions of blanching. Blanching at low temperatures (185 to 195° F.) required up to 5 minutes to inactivate enzymes, and resulted in beans of a duller green color than blanching at a temperature near the boiling point of water, requiring 2 minutes or less for enzyme inactivation. Color stability in subsequent storage was also less in the beans blanched at low temperatures. To confirm these observations, experimental lots of green beans were blanched in water and steam at 190, 200, and 212° F., for varied intervals of time from 1 to 5 minutes. During the blanching operation, some of the chlorophyll was degraded to pheophytin and this reaction served as a basis for color measurement. For samples of equivalent enzyme inactivation, differences related to blanching conditions ranged from 6% for 2 minutes at 212° F. to 17% for 4 minutes at 190° F. The color change was toward a duller green as

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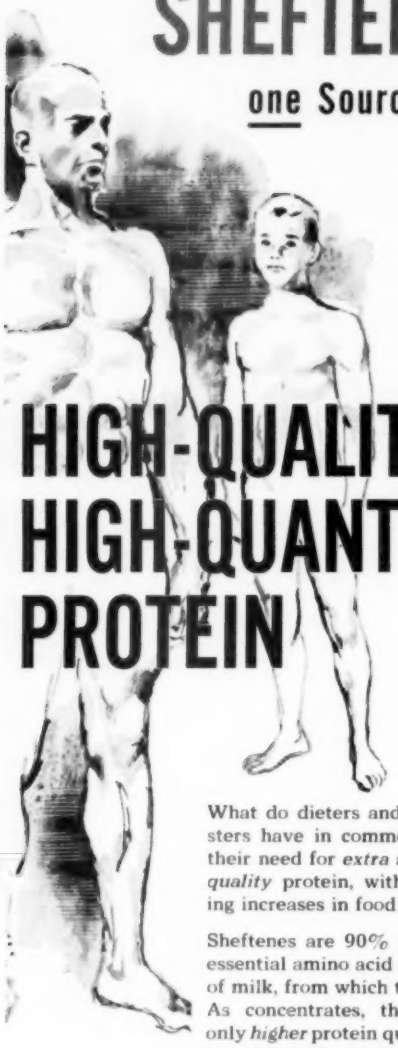

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the amount of pheophytin increased. In subsequent storage experiments, it was found that the rate of further color deterioration was lower for the high-temperature—short-time blanching conditions. (See page 258.)

Packaging — *Statistical quality control of fill, weight, etc.*

Use of extreme value control charts in food packaging operations. Mae-Goodwin Tarver and Anna May Schenck.

To assure consistent quality of precision metal parts, standard types of control charts for averages and ranges are widely used. However, in food packaging operations it is frequently more desirable to control actual maximum and minimum sample values rather than sample averages or ranges (differences between maximum and minimum values); for example, regulation of filling equipment to prevent over and under fills, setting upper and lower rejection limits for an automatic weighing device, etc. This paper describes the calculation of the chart limits and discusses some of the uses of extreme value control charts, using control of net weight of a canned food product as an example. (See page 262.)

Flavor evaluation — *Coffee (brewed)*

The influence of high temperature holding upon the components of coffee brew. Stanley Segall and Bernard E. Proctor.

Coffee brew was found to undergo measurable flavor deterioration when held at elevated temperatures for various lengths of time. This deterioration was most rapid at higher holding temperatures for coffee brew held longer than one hour. Coffee brew held at elevated temperature for up to one hour retained its flavor best when the holding temperature was highest (93° C.). The saturated carbonyl compounds content of coffee brew was found to rise with increasing length and temperature of holding. This is a possible indication of the formation of this type of compound from some substance in coffee brew. The unsaturated carbonyl compounds content of coffee brew was observed to decrease with increasing severity of treatment. This points out the possible role played by this type of compound in the flavor and flavor changes, which are associated with coffee brew. Caffeine and trigonelline were found to be stable under the most severe holding conditions used in these studies. It is unlikely that these compounds play more than a minor role in the changes in flavor which take place when coffee brew is subjected to high temperatures for extended periods of time. This does not imply that caffeine and trigonelline are not important contributors to the initial flavor experienced by the tasting of freshly prepared coffee brew. It may be that these compounds are modified in their astringent or bitter taste characteristics when present together with the other flavoring compounds of fresh coffee brew. As the more delicate flavor components undergo change, the relatively stable caffeine and trigonelline may form a larger proportion of the remaining flavor compounds and, therefore, contribute indirectly to the increase in astringent and bitter off-flavors which have been reported to develop. Chlorogenic acid is somewhat unstable in coffee brew held at the standard experimental conditions. This instability generally follows the pattern of increase with higher temperatures and longer holding times. For this reason,

it appears that chlorogenic acid may play an important role in the flavor changes in coffee brew. Studies on caffeic acid in water solution indicate that this compound exhibited marked instability when subjected to standard experimental conditions. Quinic acid was stable in water solutions held under standard test conditions. If this compound is indeed present in coffee brew in the free state, it is unlikely that it contributes in more than a minor way to the flavor changes which take place. (See page 266.)

Processing study *Yield of tomato juice*

Processing conditions affecting the yield of tomato juice. J. C. Moyer, W. B. Robinson, J. R. Ransford, R. L. LaBelle, and D. B. Hand.

The yield of juice from commercial lots of tomatoes was studied on a pilot plant basis and found to vary from 29.4 to 91.5%. Excluding the losses suffered during washing and trimming which are normally beyond the control of plant management, the greatest variation in yield occurred in the extraction operation where the skins and seeds are separated from the juice. Of the 3 methods of extraction tested (revolving paddle, tapered screw, and eccentric drum), the paddle finisher provided the widest range in yields. The temperature to which the chopped tomatoes were preheated affected the efficiency of extraction. Temperatures in the range of 140 to 160° F. gave the highest yields. When tomatoes are preheated to 200° F. or higher, the speed of a paddle finisher must be increased to maintain satisfactory yields. This leads to extremely viscous juice production. When a paddle-type finisher is used, the viscosity and yield of tomato juice are proportional to paddle speed. (See page 270.)

Radiation preservation *Milk, milk products*

Radiation preservation of milk and milk products. IX. Comparison of bactericidal effects of cathode rays, gamma rays and ultraviolet light. B. LaFuente, S. A. Goldblith, and B. E. Proctor.

This investigation concerns radiation but includes the determination of recognition threshold doses of mercury resonance radiation, a non-ionizing radiation. It was reported by Albrecht, Gunning, and Parker that such ultraviolet radiation caused virtual sterilization of raw whole milk without producing undesirable off-flavors. The present study was therefore extended and comparative data are now reported on the magnitude of off-flavors produced by (a) ultraviolet radiation, (b) gamma rays, and (c) cathode rays. The sterilization effectiveness of each type of radiation was kept equal. It has been concluded on the basis of this work that the intensity of off-flavors produced by ultraviolet radiation, gamma rays, and cathode rays is the same at the radiation levels required to successfully destroy the microorganisms present in raw whole milk. (See page 272.)

Food machinery *Potato peelers*

Comparative evaluation of various small-capacity commercial potato peelers. G. A. Pollak and H. R. Ignall.

Peeling losses of portable, batch-type, commercial abrasion potato peelers of approximately 15 lb. capacity were evaluated. Comparisons of peeling efficiencies on the basis of machine-losses alone were considered insufficient because such comparisons completely neglected the losses incurred in hand-eyeing and finishing potatoes after machine-peeling. Several different batch-load weights were machine-peeled for successive time intervals in the range of each machine from under-peel to over-peel. Both machine peel losses and hand-eyeing and finishing losses were calculated for each batch at each time interval. Mathematical analysis of the results revealed that the machine losses did not necessarily correlate with over-all losses. Graphic representation of machine losses, losses incurred in hand-eyeing and finishing, and the total of these losses showed instances where different machines produced identical machine losses at identical time-rates, yet differed appreciably in their hand finish and total losses. Different batch-load weights peeled in the same machine showed additional evidence of differing hand finish and total losses despite identical machine losses produced at identical peeling time-rates. Analysis of the peeling losses and their graphic representations showed that hand finishing losses correlated with the ability of the mechanical peeler in following the natural potato contour in its peeling action. Determinations of the efficiency of mechanical abrasion peelers were simplified by comparisons and analysis of the peeling performances and peeling efficiencies as indicated in the graphic representations of the total peel losses from all causes. (See page 276.)

Flavor evaluation *Meat*

Evaluation of flavors in meat by the use of aqueous extracts. R. A. McLean and A. M. Gaddis.

A project involving the production of flavor in cured ham, by microorganisms able to grow in curing brines, demanded a taste panel selected for a high degree of sensitivity to cured ham flavors. A group of 80 tasters consisting of both office and laboratory personnel was screened in selection of the panel. Aqueous extracts of Smithfield-type cured shoulders and of mild rapidly cured hams were used as two extremes in significant flavors. Panel members were selected for their ability to properly rank 4 samples in which the amount of extract from the stronger flavored ham was 0-33-67-100%. Cold water extracts of meat were brought to equal and palatable salt concentrations by dilution and boiled to make them safe and appetizing as bouillon. The meat extracts were served in test tubes at the desks of employees who acted as panelists. Twenty-six of the 80 original tasters were able to correctly rank the mixtures two times out of three when tried on 3 different lots of material prepared on successive dates at intervals of one to 2 weeks. The panel thus selected has been used in the evaluation of results in flavor experiments and has shown, in these, sensitivity to a related but different flavor than that used in selection of the tasters. Satisfactory agreement has been obtained by comparisons using this method of evaluating aqueous extracts and conventional taste-panel procedures on comparable solid, cooked meat samples. This result indicates that water extracts of cured ham contain the essential flavors. This technique is reported as a practical and successful means of evaluating flavor in cured ham. The method is particularly useful in evaluating results of experiments with small amounts of meat. (See page 286.)

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The Flavor of Food Technology*

Louis B. Howard
Dean and Director, College of Agriculture, University of Illinois, Urbana

IT IS A DISTINCT HONOR to be invited to speak to the Chicago food technology group on this occasion when they are touring the new administrative center of the International Minerals and Chemical Corporation, and especially the new Food and Flavor Laboratories of the Research Division. Although I have been away from immediate contact with food technology activities for almost five years, I have had a strong, continuing interest in the subject, enriched by what might be referred to as "cyclical overtones." By that I mean that when I first became actively associated with food affairs in the early 1940's, especially with pectin, fats and oils, fruit acids, and food flavors, and then with the early greatly intensified war effort on dehydration, I was perhaps at the height of my interest cycle. In fact, it was during this period of frenzy in foods that I managed to get elected as chairman of the California section of the Institute of Food Technologists—even before I was a fully approved member of the national organization! I am sure the rules are more rigorously enforced today.

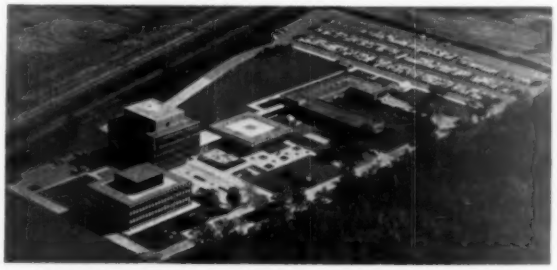
L. B. Howard

When I was called to Washington in 1945, for an administrative assignment, my cycle of interests in food technology contracted, not by choice but because I became involved in several aspects of the industrial utilization of non-food agricultural commodities. Nevertheless, in Washington, I gained at least a vicarious acquaintance with most of the food technology work of the United States Department of Agriculture. Thus, I maintained a wide interest in food research, extending from that of the fruit and vegetable laboratory in Pullman, Washington, to the citrus laboratory in Winter Haven, Florida. The panorama of food research and technology in America impressed me deeply then—and it does even more today. On balance, we have been enormously successful in progressing the science of food.

When opportunity came in 1948 to go to the University of Illinois to assist in the development of a new Department of Food Technology, it seemed like a real chance to get back to a closer contact with food research. Every region has its prized resources, but Illinois and the great Midwest have somehow exploited their agricultural resources to the full—with great farms, great packing plants, canneries, and mills, and now, in this very locality, great food research centers.

After some six years with the Food Technology Department I was moved into my present assignment, away from immediate contact with food technology. Nevertheless, my interest has been maintained through the work and growth of our department, under the leadership of Doctor R. T. Milner, and supported by his several associates. Perhaps it was again this same yearning to draw near to food technology that persuaded me, against my better judgment, to accept the invitation your chairman extended me to speak tonight. Whatever the motivation, I am very happy to be here, and I feel the cycle has expanded again and brought me into contact with a vigorous, highly effective Section of the Institute of Food Technologists. And it was in an IFT Section, you will recall, where I got my start in the cycle.

These magnificent, new facilities are at once thrilling and satisfying to me, as I am sure they are to all of you. I congratulate the International Minerals and Chemical Corporation for the foresight and accomplishment in the creation of these wonderful, new administrative and laboratory facilities. I am confident they will contribute much to the future growth and development in many areas, especially in those related to food, including its production, processing, and utilization. I am certain that Cliff Evers and his associates are justifiably proud of their new space and equipment, and will take full advantage of these facilities. This Center has a flavor, a very appealing flavor—which cues me into my topic.



International Minerals & Chemical Corporation's headquarters and research center are set in this campus-like scene in Skokie, Ill. Five-story administration building in center has heliport on top. Three-story operations building is at lower left. The research center is the one-story building at far right.

GENESIS OF FLAVOR NOT A SIMPLE STORY

I am not sure at what stage of man's evolution flavor first became important. Certainly it was a long, long time ago. It is not hard to visualize a Neanderthal housewife saying to her husband, "I wish you

* Presented before the Chicago Section, IFT, at a meeting held at the International Minerals and Chemical Corporation, Ac'cent Division, Skokie, Ill.

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would go out and bring down another mammoth. Last year's is getting over on the gamey side!" No doubt, in the early days of man, his sense of flavor and his development of a discriminating taste were important protective devices against eating poisonous foods. In his selection of fruits, nuts, and berries, assuredly he must have been guided by an intuitive dislike for plants that contained bitter and poisonous alkaloids, or avoided the consumption of animals that had been killed so long as to have become putrefied.

We know, of course, that the sense of taste or flavor is not infallible in protecting us against poisonous foods, for it is reported that some of the most delectable varieties of mushrooms harbor in their savory tissues some of the most potent glucosidal poisons. Of course, the reverse can be observed as, for example, in the case of olives—a fruit which by most standards of acceptance is wholly inedible as picked off the tree. Fortunately, man has discovered the methods of processing that convert olives to a delicacy food.

It is probable that flavor, from an aesthetic standpoint, was important to man well back into ancient historical time. When food was plentiful, he undoubtedly selected from among those fruits, nuts, and berries, the varieties that tasted best. Perhaps this sense of aesthetic discrimination even had a part in the beginning of the practice of agriculture, which we may think of as the purposeful rearing of plants and animals. Man began the practice of agriculture more than 5,000 years ago, and it seems reasonable to expect that one of the reasons he did this was because he preferred wheat, other cereals, beans of various kinds, and available edible animals, to the dried grass, tree bark, and other such unsavory items that were available to him during the winter months. Ancient civilizations in India and China are known to have employed spices and aromatics of various kinds to enhance the flavor of their food.

SPICE

Later the wide use of spices was a dominant factor in world trade, being very much in demand in the Middle Ages, probably for at least two reasons: First, because they satisfied a demand for variety in food flavors, providing new and improved flavor sensations. And second, as a means of concealing undesirable flavors that developed in their regular food as a result of spoilage. No doubt some of these spices also had a mild preservative effect. The lack of refrigeration or other satisfactory preservative means undoubtedly stimulated the use of spices in most of the warmer regions of the world.

And although our consumption of spices, on a per capita basis, has diminished somewhat and is less extensive than in India, their use is still extremely widespread. I am not sure whether the English adopted the heavily spiced curries during their occupancy of India, or whether they introduced them to the Indians. In any event, I know that as recent as a year ago, when I was in India, I found that the practice of using curries and other very heavily spiced foods still prevailed. One of the interesting items frequently used to top off a meal is called Pan. It is made in a variety of ways, but consists principally of a large green leaf, upon which is spread some hydrated lime, ground betel nut, some mint, and perhaps half a dozen other aromatic spices. Finally, the leaf is folded over and fastened with a clove. At special dinners the leaf is enclosed with silver foil. As I have said, this is the final piece at the end of a heavy meal, which is supposed to facilitate digestion and give the consumer a feeling of pleasant satisfaction. To an American I believe the greatest satisfaction is attained when he has succeeded in chewing up this whole piece and swallowing it. It does give one a feeling of achievement, but not one which he would care oft to repeat.

Certain spices were used as a medium of exchange in the early Christian era, and in fact it is said that Alerie the First, one of the early German conquerors, demanded pepper as the price for raising the siege of Rome in 408.

It was at a later period that the Turks and Mongols, during their invasions, broke the trade routes from the Far East so the Europeans who had become great consumers of spices sought new trade routes, either across Africa or around it. It was such a search for a new access route to the spices that really motivated Columbus' abortive effort to reach the East Indies. Although he did not succeed in finding the source of spices that he sought, it is likely that some of his followers could have developed a lively trade in chili

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peppers, had not plundering of the central Americans for their gold appeared more lucrative.

FLAVOR ANALYSIS—THE SEARCH FOR A SYSTEM

Man is well endowed with the senses that make flavorful food significant to him. One might develop some philosophical discussion as to whether or not flavor exists in the absence of perceptive senses in the tongue and nose and their integrating and translating counterparts in the brain. This, however, I suspect would be like the old debate whether sound exists without an ear. At least in the case of sound, we know that an orderly sequence of vibrations accompanies what we call sound. In the case of color we also know that there is a wide spectrum of electromagnetic frequencies that is associated with that kind of perception.

However, in the instance of flavor our understanding is certainly much less well developed. Whether the stimuli that produce the sensation are physical or chemical, or of what exact nature, is still an enigma. Fortunately, we have a few clues: For example, that of the relationship of pH to the intensity of the sour taste. In the case of the sensation of sweetness, it seems to be more complicated, for the structural groupings of sugar are quite remote from compounds like saccharin and sucaryl, which produce even greater intensities of sweetness. And, of course, the sensation of bitterness is utterly confusing, being present in a wide variety of chemical structures and influencing, in a few selected instances, individuals quite differently. As you know, there are a few compounds which taste extremely bitter to certain individuals and have no bitter taste whatever to others.

Salt, sour, sweet and bitter. Because of its complexity and the seeming impossibility of identifying flavor characteristics with specific physical or chemical factors, early students tried a descriptive approach. As early as 1592, one investigator classified taste in nine different categories—sweet, sour, sharp, pungent, harsh, fatty, bitter, insipid, and salty. In 1754, Linnaeus came up with 11 taste categories. To the earlier nine he added astringent, viscous, aqueous, nauseous, and from the earlier list dropped pungent and harsh. In the 19th century the pendulum swung the other way, and for a time it was considered that only sweet and bitter could be called basic tastes. Sour, sharp, saline, burning, and cool were attributed to sensations of touch. Still later, Wundt, reported to be the founder of the first experimental psychology laboratory, held to six different taste categories. These were salt, sour, bitter, sweet, alkaline, and metallic, but later two of these were dropped, leaving only the four basic categories now commonly accepted—salt, sour, sweet, and bitter. Differentiating between kinds of taste only partially satisfies the demands of the food technologist. He wants quantitative measures as well as qualitative, and so there was invented a unit of taste known as the "gust."

The gust. The gust is defined as that degree of sweetness that is tasted in a sugar solution of one per cent

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concentration. Fortunately, there appears to be a straight line relationship between the physical concentration of sugar in solution and the subjective taste intensity observed. In the case of salt solutions, an attempt is made by the observer to measure the intensity of saltiness by comparing it with a sugar solution that tastes as sweet as the other solution tastes salty. According to this system of evaluation, it is stated that single taste qualities of acceptable foodstuffs rarely exceed 50 gusts. Even combined subjective taste intensities of acceptable foods seldom exceed 50 gusts. On the other hand, certain selected foods such as lime, pickle, or lemon juice are rated in excess of 100 gusts, but of course they seldom are consumed in pure form. It seems reasonable to consider that this system represents only the beginning steps in development of a scaling procedure or flavor.

Odor. The descriptive analysis or classification of odors is much more complicated than of tastes because of the great variety of organic substances that produce stimuli. Apparently, animals are anatomically equipped for this. Over a range of animal species, the number of taste buds range from less than a thousand to as many as 48 thousand. But even such numbers as these seem trivial in contrast with the numbers of receptors that are stimulated by odors. For example, the rabbit has been stated to have from 80 to 100 million olfactory receptors, each with 6 to 12 olfactory hairs or filaments. This certainly seems to indicate a tremendously complex system, in contrast with not only the sense of taste, but also with the sense of sound in which it is reported the ear is possessed of some 30 thousand auditory nerve fibers.

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In the case of color, it is reported that there are but four psychologically pure colors—red, yellow, blue, and green. Nevertheless, it has been found that with the three primary colors (red, yellow, and blue) mixing can reproduce all colors experienced by the human eye. I am sure that you are all acquainted with the Munsell color scale and its great practical value to food technologists. Actually, the Munsell color scale essentially is a scale of "just noticeable differences," and its success in the treatment of color makes the food technologists yearn for a Munsell diagram for taste and smell.

EVALUATING FLAVOR BY SUBJECTIVE TESTS

In spite of these apparently insurmountable obstacles, some progress has been made in the descriptive classification of odors and in a measure of their intensities. Perhaps the most widely used and accepted technique at the present time is that known as the flavor profile procedure—an analytical descriptive procedure, devised at the Arthur D. Little Company Consulting Laboratories.

The number of subjective tests that have been devised in attempting to evaluate flavor in various kinds of products is almost legion, and I shall not go into any discussion of these different procedures tonight. However, they may be categorized essentially as follows:

1. The individual expert, making fairly rapid judgments, often used in making decisions concerning the

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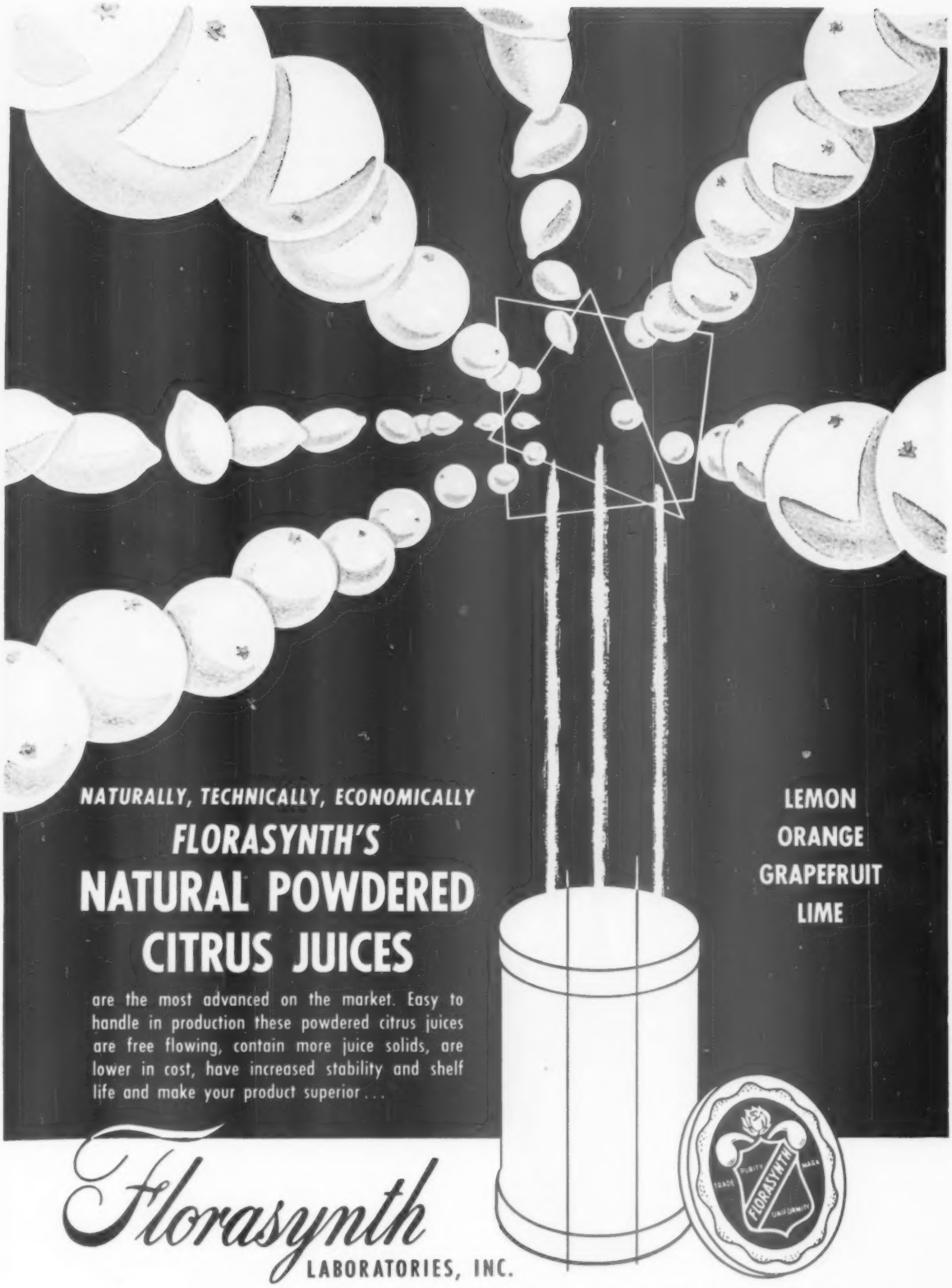

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purchasing or processing of materials. The individual expert may be incredibly acute, but not necessarily and not very likely representative of the mass of consumers. Nevertheles, the individual expert has been used many years, especially in the areas of wine, tea, and coffee tasting.

2. The small expert panel, usually consisting of from 4 to 6 individuals, selected if possible from the laboratory personnel. Such a panel is useful for picking apart the flavors of products, matching a desired result, and determining the effects of changes in raw materials or of processing methods on the quality of the final product. Where possible, such observations are coordinated with physical and chemical analyses.

3. The trained, but not expert, difference panel, sometimes consisting of as many as 15 or more persons. Such a panel is useful for determining the presence, nature, and extent of possible difference, but is not generally acceptable for preference testing.

4. The untrained preference panel that may be used for developing preliminary indications of flavor and odor preference or acceptability. The conclusion arrived at by such panels usually are not accepted as final, but as indicative and may serve to guide further changes in compounding or modifying proposed products.

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5. The large-scale consumer panel, in which as many as a thousand or more individuals may be involved as a final check on the consumer acceptance before actually making test marketing trials.

Two parts per trillion. Certainly the organs of sensation possessed in our tongues and noses are remarkable beyond description in their sensitivity. Any sense organ that can detect most odorous materials in quantities of a few parts per billion, and in the case of certain selected ones, such as ethyl-seleno-mercaptan which is detectable in two parts per trillion, is almost beyond our capacity to comprehend. It is reported that in ethyl alcohol, a contamination of ethyl mercaptan can be detected in two parts per billion and that customers will reject the product that contains 10 to 20 parts per billion. In such cases, the human nose is much more sensitive than present analytical instruments.

NEW TOOLS AND TECHNIQUES

So the problems of flavor in food products, as well as in nonfood products, present a very challenging field for the food technologists and those associated with him. Many advances have been made in the development of physical procedures and equipment to assist in these studies, and I should like to describe but a few of these that are currently being found very helpful in studying the flavor complex.

One of the most complicated and expensive of these is the mass spectrograph, an instrument devised by physicists to sort atoms according to their weight. F. W. Aston received the Nobel Prize in Chemistry in 1922 for his development of this instrument. He used it to discover 212 of the 281 naturally occurring isotopes. Only in recent years have food technologists realized that this instrument not only can distinguish between complex molecules differing in weight by only one hydrogen atom, but can perform this feat on a very small amount of material—literally a smell. Thanks to the extensive work of petroleum chemists who were among the first to exploit the mass spectrograph, it is possible to determine both qualitatively and quantitatively the composition of a few micrograms of liquid or gas.

PARTITION CHROMATOGRAPHY SHOULD STEP UP FLAVOR RESEARCH

Another powerful tool for separating and identifying constituents of a complex mixture available in only small amount is partition chromatography. Again the British discoverers of this procedure, Martin and Synge, were rewarded by the Nobel Prize in Chemistry in 1952. Chromatography as a method dates back to the Russian botanist Tswett, who published his method in 1903, but the development of partition chromatography as used with paper and with liquids and gases has made possible some remarkable advances. Microgram quantities of pure compounds can be readily separated and identified on filter paper with relatively cheap equipment. With gas-liquid chromatography it appears that the dream

of the food technologist may be realized and that it will be possible to isolate and identify the individual pure compounds that unite to make up the delicious and elusive odors we associate with food. The principle is simple:

A column of inert material, such as crushed firebrick particles, is impregnated with an inert, nonvolatile liquid. A carrier gas such as helium sweeps through this column and carries the unknown material in vapor form. The column with its millions of liquid coated particles acts almost as a distillation column with an equal number of plates. From the exit end, the helium stream emerges with first one, then another pure compound. The presence of any compound in the helium is shown by thermal conductivity and recorded as a peak on a chart. The time which is required for a compound to pass through the column is related to its composition and the height of the peak shown is related to its concentration. Best of all, the peaks are usually separated sufficiently so that a series of very pure compounds emerges when a mixture is introduced. It is evident that a gas-liquid chromatography apparatus feeding into a mass spectrograph offers an exceedingly powerful method of attack.

In spite of these greatly improved and powerful tools, progress in flavor and odor identification will remain slow and laborious. The large Western Regional Laboratory (where I reached the height of my first cycle of interest in food technology) has worked for several years on the flavor and aroma of strawberries. They have used tons of strawberries to obtain essences which, after further concentration, have been subjected to gas-liquid chromatography and mass spectrography. From this have come over 30 pure compounds which have been positively identified and many others whose identity is now being studied. Nevertheless, no one can yet compound a mixture equivalent to natural strawberries. The trained taste panel can still differentiate between the best synthetic effort and the natural product.

THE HUMAN SENSES NOT LIKELY TO BE SUPERSEDED BY INSTRUMENTS

So far we have spoken about the analysis of flavors and odors into their separate constituents. Actually we know that the synthesis and combining of different flavors and odors is a most essential part of our enjoyment and appreciation of food. The famous French chefs who invented sauces were perhaps the first to appreciate the importance of these blends. It may be no coincidence that both the cooks and perfumers of France are masters in their respective fields. The perfumer utilizes some very peculiar odors to furnish the base and accent the delicate overtones of his creations. When it comes to accent, our hosts this evening have furnished an outstanding example of what "Accent" means. The place of monosodium glutamate in the orchestra of flavors is a most important one. Time is lacking to even list the foods where it is an essential ingredient. The food technologist is still far from explaining its action or finding limits for its use.

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Instead of being discouraged by this, I think as food technologists we should rejoice. No automation is going to be able to replace us. As I have said before, our tongues and noses are sensitive, at least to some compounds, far beyond the limits of any machine yet devised. Until we can label odors with radioactive materials and count the scientillations of the separate molecules, we shall have to trust our palates. It is the recognition of the complexity of foods, their delicacy, and the care with which they must be prepared and stored that furnish the true "flavor" of food technology.

IFT NEWS

Awards

Dr. Berton S. Clark Named Nicholas Appert Awardee for 1959

Dr. Berton S. Clark has been selected as the 1959 Nicholas Appert Awardee, according to an announcement by H. C. Spencer, Chairman of the IFT Awards Committee. The Appert Award signalizes outstanding achievements in food technology and research. Dr. Clark is well known in the canning, can-making, and allied industries for the scientific contributions he has made to their basic problems. He has also distinguished himself in industry, professional, military and Government affairs.

B. S. Clark

Dr. Clark first became engaged in the problems of tin plate corrosion in 1915, an activity which continued through his participation in the tin conservation program of 1939–1946. He was one of the originators of the protective shipping container widely used for ocean tin plate shipments to the West Coast. Modern physical and chemical specifications for tin plate and certain of the methods used today for commercial plate evaluation and control can be directly traced to the work initiated by Dr. Clark and his associates. This was a major development within his industry. A popular account of Dr. Clark's contributions appeared in *Fortune Magazine* (January, 1941).

ASSOCIATED WITH BOTULISM CONTROL

In the mid-20's, then stationed in California, Dr. Clark became intimately associated with public health agencies in the control of botulism by adequate heat processing. He assisted in developing the California State regulations for control of botulism by adequate heat treatment and was among the group which in 1928 issued the first list of recommended processes for low-acid food susceptible to botulism.

Over the years, above and beyond his nominal duties and responsibilities, Dr. Clark has constructively served as a member or officer of special technical committees such as those of the National Research Council; the Can Manufacturers Institute; the National Canners Association; Munitions Board; Quartermaster Food and Container Institute for the Armed Forces; Institute of Food Technologists, and others. As a mark of recognition of the man and his abilities, his notable officerships include the Presidency of IFT ('53–'54); Chairmanship of the Board of the Qm. Research and Development Associates ('50–'51); and Chairmanship of the NRC Committee on Packaging ('48–'54).

In his present position, Dr. Clark designed, equipped and established the first laboratory sponsored by the sardine canning industry. From this laboratory, within the first two years of its operation, has come a practical system for quality grading of canned sardines. This project had been a research objective of that industry for several decades.

"A DISTINGUISHED DIPLOMAT IN SCIENTIFIC AFFAIRS"

Dr. Clark has the respect and confidence of his colleagues and friends, due both to his scientific perception and his personal qualities. Often conservative, he gives opinions contrary to his own full and courteous consideration. Where required, he freely compromises on courses of action; where he is constrained to differ, he does so only after a complete and rational explanation of his own position. It is this general aspect of the man that has brought the many requests for his services on groups or committees confronted with contentions or competitive situation. He has been, in a word, a distinguished diplomat in scientific affairs and, in his own right, a contributor to scientific progress.

Dr. Samuel Lepkovsky Chosen Babcock-Hart Awardee for 1959

Because of his outstanding contributions to nutrition over the past thirty-five years Samuel Lepkovsky has been named Babcock-Hart award winner for 1959. This Award, established by the Nutrition Foundation, Inc., is given to an individual whose scientific work has influenced the nutritional well-being of the general population. As a former student of the men in whose names the award is made, Dr. Lepkovsky is a credit to their teaching and richly merits the honor that has come to him.

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WRITE FOR LITERATURE

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Samuel Lepkovsky, born in Poland on 12 February 1899, has been a citizen of the United States since 1908. He is a graduate of the University of Wisconsin with the degrees of B.S., in 1920, M.S., 1923, and Ph.D. in nutrition, 1925. He was an assistant in agricultural chemistry from 1919 to 1922, and instructor from 1922 to 1925 and research associate, 1925–1928.

Samuel Lepkovsky

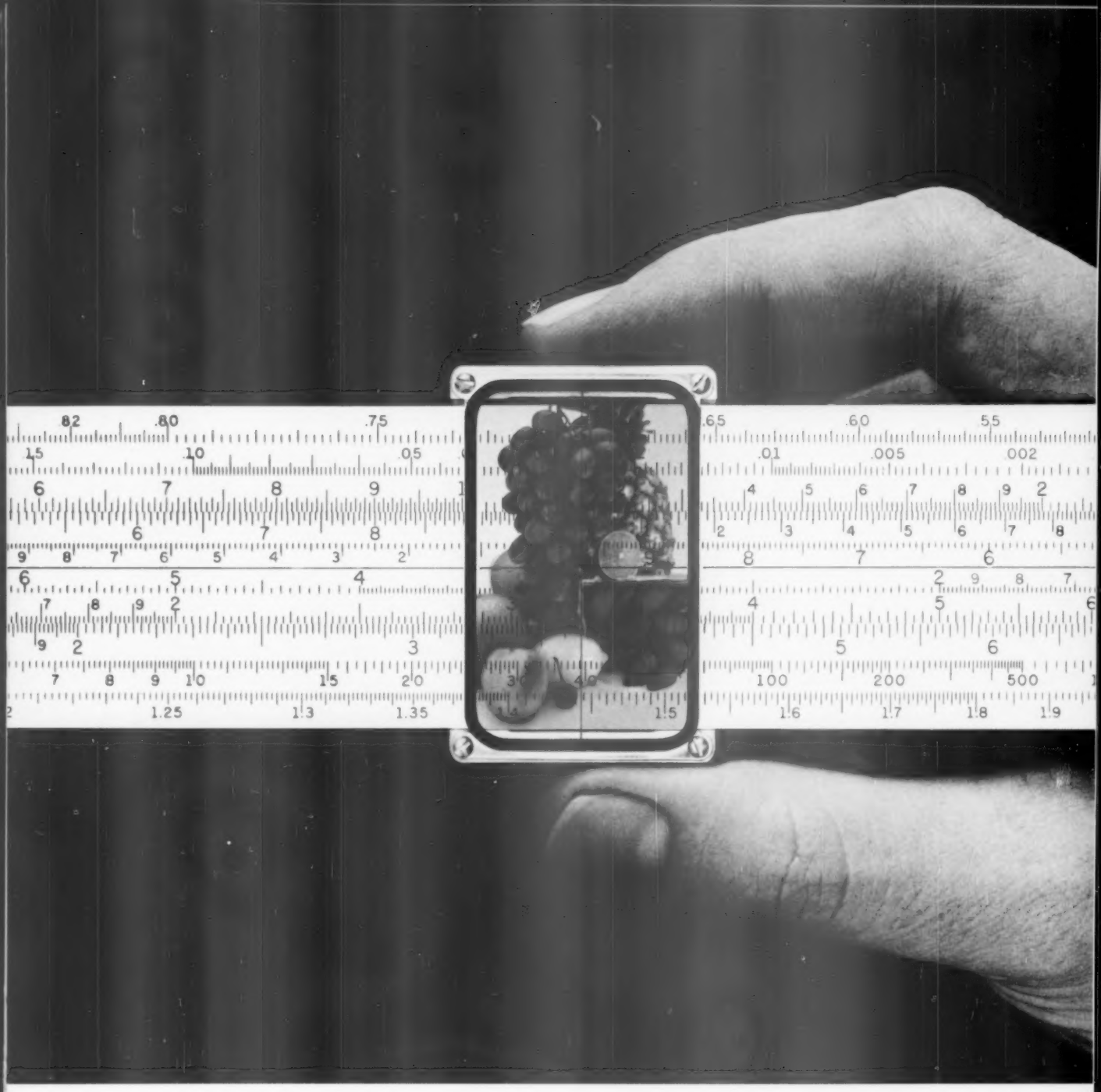
In 1928 Dr. Lepkovsky became associated with Dr. H. M. Evans at the University of California, at a time when there was a very active research program in nutrition under the general direction of Dr. Evans. Rising through the ranks, he was made a full professor at the University of California in 1945.

Dr. Lepkovsky's interests have centered around nutrition from the start. His first publication, jointly with E. B. Hart and C. G. Humphrey, appeared in the *Journal of Biological Chemistry* in 1920. He is joint author with Dr. Hart of seven additional papers in the field of nutrition, and with other associates at the University of Wisconsin of seven additional pioneering papers concerned chiefly with the growth factors in nutrition. He has a bibliography in excess of 100 titles, each paper, without exception, dealing with some aspect of nutrition. In his early years at the University of California his research centered around the B vitamin complex and the nutritional significance of lipoids. He is a joint author with Evans of a series of some seven or eight papers on the sparing action of fats on Vitamin B, and of a number of papers concerned with the nutritional significance of certain unsaturated fatty acids.

PIONEER IN RIBOFLAVIN RESEARCH

He was a pioneer in research on riboflavin. He processed several hundred thousand gallons of milk to isolate and crystallize a considerable quantity of this vitamin. In the early 40's Dr. Lepkovsky became interested in research with the factor which later proved to be pyridoxine (B_6). He isolated, crystallized and identified this vitamin concurrent with, but independent of, the discoveries by Merck biochemists. In connection with his research with the purified factor, Dr. Lepkovsky observed a green pigment in the urine of deficient animals. This he was able to identify as xanthurenic acid, and through these observations made a noteworthy contribution to establishing B_6 as a required growth factor.

During World War II Dr. Lepkovsky was called to the Office of the Quartermaster General in Washington where he devoted his time to the development of nutritionally sound acceptable rations for the armed services. He made significant contributions through counsel and advice in the development of



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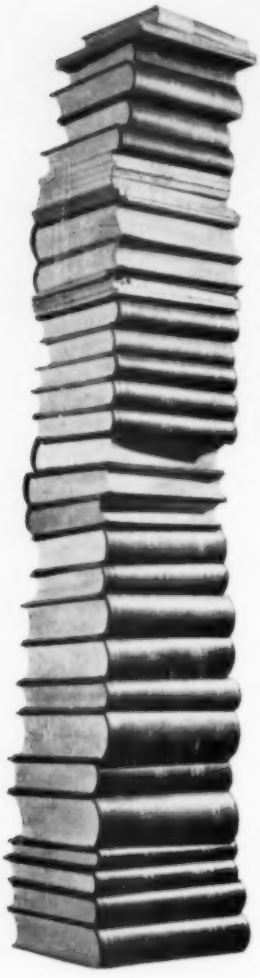

Words, words, words—about vitamin A. Anyone wanting to bone up on the subject would soon find himself plowing through this monument to the verbal vigor of our own staff since the early thirties, when we began our vitamin A research.

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improved quality in meats, fruits, and vegetables. His contributions to the nutritional adequacy of survival (absolute minimum) rations are especially noteworthy.

He was much concerned with the development of very significant information about the browning reaction which results from storage deterioration of a number of dried fruits and vegetables. As a result of this reaction there is not only a flavor change, which frequently results in a lowered acceptability of the food, but a real decrease in nutritional value and actually a depression of appetite.

His more recent nutritional interests are partially illustrated in two review articles under his authorship in *Advances in Food Research*. These are "Physiological Basis of Voluntary Food Intake (Appetite?)" and "Stress Nutrition."

NOTABLE PUBLIC SERVICE

Dr. Lepkovsky has not restricted his public service to his adopted country. He has been an advisor to the Government of Israel on more than one occasion. He served as Agricultural Officer, FAO, United Nations, in 1952 and as a Nutritionist in 1958.

As a man he is modest and unassuming. He is unselfish to an extreme degree. He will lend a helping hand, either actually or through advice and counsel to anyone who seeks his help.

Potato Flakes Win IFT's First Food Technology Industrial Achievement Award

The IFT will hail a completely new dehydrated mashed-potato product—potato flakes—at its Annual Convention in Philadelphia, on May 18. The Eastern Utilization Research and Development Division of the USDA's Agricultural Research Service will be recognized for its development of potato flakes by becoming the first recipient of the IFT's Food Technology Industrial Achievement Award. It is appropriate that the honor should be bestowed in Philadelphia, the location of the Eastern Division, where potato flakes originated and were first made on a pilot-plant scale less than five years ago.

THE INVENTORS

The potato-flake process was invented by two chemical engineers, James Cording, Jr., and Miles J. Willard, Jr., and the development was carried out under the direction of Roderick K. Eskew, Chief of the Eastern Division's Engineering and Development Laboratory. Plaques will be presented to the men responsible for the achievement in ceremonies at Philadelphia's Bellevue-Stratford Hotel, as part of the convention proceedings.

First made commercially only a little more than a year ago, potato flakes have achieved a phenomenal success. Total production this season in the 7 U. S. plants where flakes are now being made should

Stir this distilled monoglyceride into cottonseed oil

heat to about 75°C; cool

and the oil becomes a stiff solid.

It takes only a small percentage of monoglyceride made from a saturated fat to stiffen any liquid triglyceride. The crystalline matrix holds the oil with practically no leaking, and the stiffened product stores well.

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Dr. Roderick K. Eskew (left) and Dr. P. A. Wells, EURDD director (center), discussing the end product of the process with James Cording, Jr. (right). Mr. Miles J. Willard, Jr., also included in the citation, was unable to be present when this photograph was taken.

reach 25 million pounds. Nationwide distribution to the retail and institutional trade is rapidly being approached.

The development has meant a great deal to agriculture, for it has provided potato growers with a new and profitable food outlet for their crops. And the benefit is not limited to those areas of the country where high-solids varieties are grown. The process is adaptable to potatoes of many varieties from many growing areas.

THE PROCESS

The flake process is simple. It consists essentially of drying freshly mashed potatoes on a drum dryer such as is used in potato-flour plants. In about 20 seconds, the potatoes come from the dryer in the form of a parchment-like sheet containing 4½ to 6 per cent moisture. An attachment on the dryer cuts the sheet into flakes of the desired size for packaging.

An essential feature of the process is that the potatoes are precooked in water and cooled before they are steam-cooked and riced for application to the drum dryer. These preliminary steps improve the texture of the mash and of the final product when it is converted back into mashed potatoes. They are also the steps that make it possible to produce flakes from many varieties of lower-solids potatoes. The principle of precooking and cooling discovered in the course of this development is not only applicable to flakes, but is important to the entire potato-processing industry as a means of controlling the physical properties of potato products.

International Award for 1959 To Be Conferred On Canadian Scientist

Dr. Ross A. Chapman of the Food and Drug Directorate, Department of National Health and Welfare, Ottawa, Canada, has been chosen to receive the 1959 International Award. The International Award was established by the Australian Regional Sections for distinguished service in promoting the international exchange of ideas in the field of food technology. The Award, consisting of an engraved silver salver, commemorates the Awardee's contribution to better international understanding through science.

Dr. Chapman has been instrumental in major degree in furthering the international exchange of ideas in the food field, both through his work in the Canadian Food and Drug Directorate and as Scientist (food additives) in the United Nations' World Health Organization at Geneva from 1954 to 1957. In this latter capacity he was responsible for organizing the collection and dissemination of data on food additives, advising member nations on this subject, coordinating and fostering food additives research, and promoting a greater degree of uniformity in legislation relevant to additives.

Dr. Emil Mrak Named Chancellor of University of California at Davis

Dr. Emil M. Mrak, one of the nation's outstanding food scientists, head of the University of California's Department of Food Technology at Davis and Berkeley, and IFT president in 1957–1958, has been named chancellor-elect of the Davis campus. He succeeds Chancellor Stanley B. Freeborn who retires July 1.

E. M. Mrak

A native of San Francisco, Dr. Mrak received his B.S., M.S., and Ph.D. degrees from the University of California. During World War II he played an active part in a scientific effort to bring military subsistence items to the point where they could withstand the rigors of military handling in extreme climates. He continued that work after the war as head of the Committee on Food Research of the Quartermaster Corps.

Now a member of the food protection committee of the National Research Council of the National Academy of Sciences, he has also served on committees of the National Research Council, Office of Naval Research, and U. S. Public Health Service.

Dr. Mrak has lectured to Swiss food technologists and studied the status of food technology in Brazil and made recommendations for its improvement. His early research dealt with the food value of prunes. He has since made extensive studies of corrosive action of fruits on metal containers; on sun drying and other means of food preservation; on retention of vitamins in processed foods; on relation of maturity of fruit to processed quality; and on the role of additives in food processing. He has taken a special interest in the ecology of yeasts and particularly those associated with foods, and the effects of various processing techniques on this activity.

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And between soup and dessert, Sunkist devised enough manufacturing processes for the benefit of the American food processor to get Sunkist 118 separate U.S. patents!

Sunkist technical experts will be glad to work *with* you – in your own plant – or *for* you – in their own citrus research department. Write – or, if it's urgent, telephone – and a Sunkist man will call on you.

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REGIONAL NEWS

MARYLAND
WASHINGTON, D. C.

At a joint dinner meeting of the Maryland and Washington Sections, held in March at the Agricultural Research Center, Beltsville, Maryland, 100 members and guests heard an address by Dr. Aksel G. Olsen, President of the Institute of Food Technologists. After bringing the local sections up to date on national affairs of the Institute of Food Technologists, he presented an excellent talk on "Industrial Research and Research Planning." Dr. Olsen pointed out, that the justification of an investment in commercial food research was the anticipation of a profit from such research. He stated that the modern consumer of foods is looking for 1—palatability; 2—convenience; 3—economy; 4—nutrition. A formula that he considers to be satisfactory for commercial food research is P-O-D-C-C (Planning, Organization, Directing, Check Listing, and Control).

Stimulated by Dr. Olsen's remarks, the members and guests present had many questions for Dr. Olsen and a lively discussion followed.

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MEXICO

At a recent meeting of the Mexico section of the Institute of Food Technologists, Ray B. Wakefield, president-elect of the International IFT, spoke on the future horizons of the food industry.

The meeting was held at the very modern factory of Industrias Carrencedo, S. A. The generous hostess served a nutritious buffet supper to the more than 80 members and visitors in attendance. The supper was preceded by a guided tour of the various departments of the plant by the owners and employees of Industrias Carrencedo.

President of the Institute of Food Technologists, regional section No. 26 of Mexico, is Amaury Carbajal. Among those in attendance at the February meeting were former-president of the IFT, Walter E. McAllister, Miss Emma Balboa, secretary; Juan Schwarz, Phil McGuire, general manager of Carnation de Mexico; John Burrows, general manager of Helados Holanda; Dr. Ricardo Millares, former president, Marcial Ibarra, and numerous others.

MOHAWK VALLEY

A record crowd attended the Tuesday evening, March 17 meeting of the Mohawk Valley Section, bulging the walls of the rather small Old Schoolhouse Restaurant at St. Johnsville, N. Y. Several guests from the expanding laboratories of Salada-Sherriff-Horsey (formerly Junket) were in attendance.

The speaker of the evening was Dr. T. A. White who is Technical Director for foods at National Starch Products, Inc. He spoke to us about "Corn Starch—The New and the Old."

BRITISH COLUMBIA

A most enjoyable and informative evening was spent by the thirty members who came to the Agricultural Engineering Building at The University of British Columbia on Monday, March 9 to hear Mr. Ray B. Wakefield, President-Elect of IFT and Director of Research and Quality Control, Gerber Products Co.

Mr. Wakefield spoke on "Quality Control, a Management Philosophy." He illustrated his main points with practical examples, and in so doing aroused the interest of the audience in a most satisfying manner, with a question period that continued for over an hour. Mr. W. Blankenback, B. C. Sugar Refinery, thanked the speaker on behalf of the group, and pointed out that one of the reasons for the intense interest in this topic is that many of our Quality Control programs are still in the pioneering stage. Hence the members found Mr. Wakefield's remarks particularly pertinent to their own problems.

The following officers for the coming year were elected: Chairman, H. S. Murdy, Continental Can Co.; Vice-Chairman, R. S. Bolton, Department of Fisheries; Treasurer, M. H. Goodman, Pacific Coast Packers; Secretary, Miss M. Poolton, Home Economics

Department, U. B. C.; Councillor, Dr. D. H. McGregor, Summerland Experimental Station. Because the councillor has a three year term, Dr. McGregor has two years to serve.

Chairman Charles Bullen adjourned the meeting at 9:45 p.m. for coffee and doughnuts and informal discussion continued till 10:30 p.m.

AUSTRALIA N.

By way of review of recent meetings, we record the following:

November meeting. On Thursday 20th November, some 58 members and visitors assembled at CSIRO, Homebush to take part in a Symposium on Rice. The meeting, as always got off to a very good start, thanks to Mrs. Hooper and her aides. The technical programme was most enthusiastically received, and this was entirely due to the stimulating papers presented, which covered most aspects of the rice picture.

W. S. Beale gave us a most interesting insight into the tremendous project at Humpty Doo, with all its problems. Two members of the CSIRO Research team followed with an outline of some technical problems encountered in the preparation and use of rice in canned foods. E. W. Hicks dealt with the drying of rice and D. J. Casimir with its use as an ingredient in speciality products.

The programme was rounded off by a film, courtesy of the Australian Rice Board. The attendance was easily a record for a Technical meeting, and reflects credit on the Programme Committee and also perhaps on the increased enthusiasm, lately in evidence, among members.

Xmas barbecue. In the late hours of Saturday afternoon, December 13th—50 bodies—men, women and children, of the IFT forded the George's River, and descended upon the David Estate for the Annual Xmas Barbecue. That all were sharp in both appetite and thirst was evidenced by the rapidity with which steaks and trimmings disappeared. It is rumored, too, that for the first time on record demand exceeded supply for a certain amber liquid that both refreshes and cheers. However, an express delivery from a local establishment arrived in time to save the day.

February excursion. On February 5, 6, 7th the Hunter Valley Excursion was laid on, a most enjoyable event. Highlights of the excursion included arrival at Maitland, a visit to the mechanized coal mine at Mt. Sugarloaf, inspection of the Hexham Factory of the Hunter Valley Co-op, a trip through the Balwood Vineyards and Winery, a tour of the Muswellbrook plant of the Hunter Valley Co-op—and, prior to the return trip to Sydney, lunch at Glenbawn Dam. Peter Crocker of Albright and Wilson was in charge of arrangements for this interesting and informative trip.

CHICAGO

The W. F. & John Barnes Company at Rockford, Illinois served as host to the Chicago Section IFT for

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Receiving plaque in recognition of winning Gerber award for outstanding scholarship in Food Technology course is Kenneth Lebermann (left), of Rock Island, Ill., a student at the University of Illinois. The award was presented at the Chicago Section dinner February 9 by Ray B. Wakefield (center), director of research and quality control of Gerber Products Company, Fremont, Michigan, and president-elect of the Institute of Food Technologists. Ac'cent Division of International Minerals and Chemical Corp. was the host. At right is Dr. Reid T. Milner, head of the food technology department at University of Illinois. The award, one of six given annually in the United States and Canada, carries a $1,000 scholarship.

our March meeting. There was a general tour through company facilities with demonstrations and discussions (1) at the Midwest Irradiation Center with a short talk and inspection of the Arco Linear Accelerator, (2) at the Electrical Controls Division on control systems applicable to the food industry, and (3) at the Food and Container Assembly area of a new automatic case packer for glass, and a short talk on other Barnes activities in the food and container field.

W. F. & John Barnes Company has been actively engaged in engineering and manufacturing equipment since 1872. Their present business consists of developing, designing and building specialized mechanical, hydraulic, and electrical equipment of all sorts. They do not sell items; rather, they sell creative service, design and build equipment. Of special interest to the food industry are their activities in the areas of special handling and conveying equipment, special electrical controls and complete production facilities development, including aseptic canning units and can handling systems.

Dinner, preceded by a cocktail hour, was served at the Faust Hotel in Rockford. An excellent exposition of the interests and activities of the Barnes Co., with special reference to its irradiation facility, was given by representatives of the Company.

WASHINGTON, D. C.

The year 1958 was a charter year for the Washington Section of the Institute of Food Technologists. The first meeting in January was devoted to the development of program and policy, adoption of by-laws, and election of officers. Officers for the year 1958 were:

Chairman, Dr. Charles H. Mahoney of the National Canners Association; Vice Chairman, Mr. William J. Hoover of the Corn Industries Research Foundation; Secretary, Mrs. Elsie H. Dawson of the United States Department of Agriculture; Treasurer, Dr. Robert C. Wiley of the University of Maryland; Councilor, Dr. Frank L. Gunderson, Consultant in Food Technology.

Considerable interest in the formation of a Washington Section of the Institute of Food Technologists was shown by the good attendance at the Section meetings in February and March. Therefore, application for a charter was made on March 24, 1958 with a charter membership of 119 persons. The charter was presented to the Washington Section at the Eighteenth Annual Meeting of the Institute of Food Technologists on May 25, 1958 at the Palmer House in Chicago, Illinois. The charter for the Washington Section with the names of the 119 charter members was framed for display. By the end of the first year of its existence the Washington Section had 144 members, and expects to grow to be an important and useful organization in our National Capital, Washington, D. C.

A resumé of our first year's program follows:

January 8, 1958—Adoption of By-Laws; Election of Officers; and Development of Program and Policy.

February 21, 1958—"The Food Protection Committee."

A. Its purpose and function, operation and program, results and significance to the food industry. The Panel: Dr. Frank L. Gunderson, consultant, Washington, D. C. and Councilor of the Washington Section. Dr. David B. Hand, Head, Department of Food Science and Technology, Cornell University and Vice Chairman of the Food Protection Committee. Dr. Emil M. Mrak, Chairman, Department of Food Technology, University of California and President of the Institute of Food Technologists.

B. The Institute of Food Technologists in 1957–58. Dr. Emil M. Mrak.

C. Procedure for Obtaining a Charter for a Regional Section. Colonel Charles S. Lawrence, Executive Secretary of the Institute of Food Technologists.

March 27, 1958—Panel Subject: "The Enzyme Catalyzed Browning Reaction, Its Mode of Action and Examples of the Reaction in the Food Industry. Speakers: Dr. H. W. Seigelman, well-known biochemist of the U. S. Department of Agriculture, presented a discussion of the basic properties of the enzyme and the nature of the substrate involved in the reaction. Dr. L. E. Scott of the University of Maryland presented examples of the browning reaction and its control in certain food products.

May 15, 1958—Program: "Animal Products Research at Beltsville." Round table presentation of the organizations and programs concerned with research on animal products in the U. S. Department of Agriculture. Speakers: Dr. Richard Hiner, Dr. Ruth McLean, Dr. Adam M. Gaddis, Mr. Clifton E. Swift, and Dr. William L. Sulzbacher who was chairman of the round table. A social hour with refreshments followed the technical program.

June 19, 1958—Program: "Observations on Food Research and Problems in Europe—Possibilities of U.S.D.A. Utilization Research in Europe." Speaker: Dr. G. E. Hilbert, Assistant Administrator, Utilization Research and Development, Agricultural Research Service, U. S. Department of Agriculture.

September 29, 1958—Program: "Principles and Techniques of Color Measurement." Speakers: Professor Amihud A. Kramer, Department of Horticulture, University of Maryland, and Mr. John N. Yeatman, Quality Evaluation Section, Biological Sciences Branch, Marketing Research Division, Agricultural Marketing Service, U. S. Department of Agriculture.

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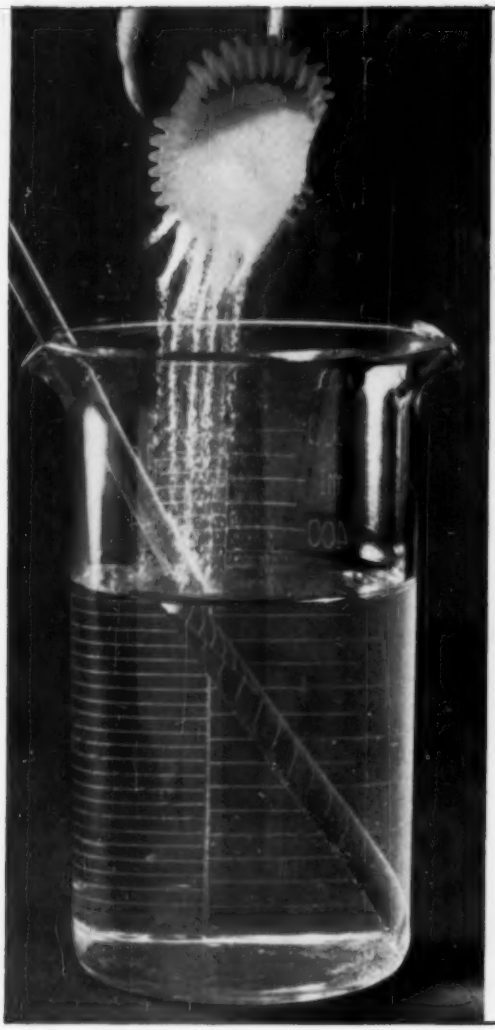

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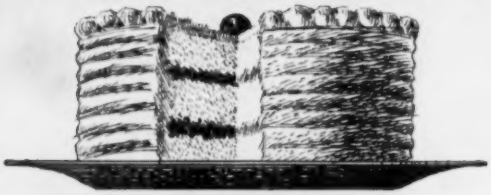

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October 30, 1958—Program: "Time-Temperature Tolerance of Frozen Foods," and "Industry Views on a Frozen Food Code for Handling and Sanitation." A report on the team research project which won a U.S.D.A. Distinguished Service Award in 1958, by Mr. William F. Talburt, Fruit and Vegetable Laboratory, Western Utilization Research and Development Division, U. S. Department of Agriculture. Dr. H. P. Schmitt, National Association of Frozen Food Packers, Washington, D. C. gave a summary report on a code sponsored by the Association of Food and Drug Officials of the United States and the National Association of Frozen Food Packers.

December 4, 1958—First Annual Dinner Meeting. Program: "What the Consumer Expects in a Food Product Today." Speaker: Miss Edalene Stohr, Director of Home Economics, American Can Company, New York, New York.

—Elsie H. Dawson

S. CALIFORNIA

Ray Wakefield, National President-elect of the Institute of Food Technologists, was the feature speaker at the regular meeting of the Southern California Section of this organization held on Wednesday, March 18, 1959, at the Roger Young Auditorium in Los Angeles. Mr. Wakefield is Director of Research for Gerber Products Company, spoke on the very interesting subject "Horizons in the Food Industry." He displayed a keen insight into past, present and future trends in the processed food industry. The effects of future wars, space travel, and a predicted rapid increase in population on the food industry were discussed. These factors offer a challenge to food technologists and indicate the need for technical progress and expansion in the food industry. Mr. Wakefield suggested that future developments in the food line could be the development of special food for older persons and the development of new and improved foods resulting from an increase in the standard of living of the American people. The talk was well received and was followed by an active question and answer period.

The April meeting of the Southern California Section of IFT featured Mr. W. Ray Junk, Manager, Industrial Sales and Service Department, of California and Hawaiian Sugar Refining Corporation, speaking on the subject "Recent Food Research Work Sponsored by the Sugar Research Foundation." Mr. Junk, a graduate of Iowa State University, is a director of the Sugar Research Foundation. He has been exceptionally active in IFT affairs in the Northern California Section and, during World War II, was executive officer of the Subsistence Section Research and Development Branch of the Office of the Quartermaster General, Washington, D. C. He discussed activities of the Sugar Research Foundation including the present status of projects in Sucrochemistry such as plastics, surfactants and sponsored research projects in the Food Technology field.

—E. Kyle Bacon

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

May 17–21	**Nineteenth Annual Meeting of the Institute of Food Technologists, Bellevue-Stratford Hotel, Philadelphia, Pennsylvania**
June 7-11	76th Annual Convention of the National Confectioners Association, Conrad Hilton Hotel, Chicago
June 9-13	Second Inter-American Food Congress, Carillon Hotel, Miami Beach, Florida
June 10-12	Second International Symposium on Gas Chromatography, Kellogg Center, East Lansing, Michigan
June 11-12	Canadian Institute of Food Technology, 2nd National Conference, Royal York Hotel, Toronto
June 15-Sept. 4	Gordon Research Conferences, Colby Junior College, New London, New Hampshire
August 19-26	10th International Refrigeration Congress, Copenhagen, Denmark
August 25-28	42nd Annual Meeting of the American Dietetic Association, The Statler Hilton Hotel and Shrine Convention Hall, Los Angeles, California

1960	
May 15-19	**Twentieth Annual Meeting of the Institute of Food Technologists, Fairmont Hotel and Masonic Temple, San Francisco, California**
1961	
May 7-11	**Twenty-first Annual Meeting of the Institute of Food Technologists, Hotel Statler, New York, New York**
1962	
June 17-20	**Twenty-second Annual Meeting of the Institute of Food Technologists, Amercana Hotel, Bal Harbor, Miami Beach, Florida**

An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, 11606 South Bell Avenue, Chicago 43, Illinois notices of annual or national meetings of interest to food technologists.

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Approximation of Surface Areas of Cut-Up Chicken and Use in Microbiological Analysis[a]

Harry E. Goresline and Raymond R. Haugh

Quartermaster Food and Container Institute for the Armed Forces
Chicago, Illinois

(Manuscript received May 31, 1958)

ESTABLISHING THE SANITARY quality of poultry products is essential to good processing, handling, and storage. Poultry of good sanitary history and low microbial flora keeps longer in channels of trade and also maintains a good appearance. Low bacterial counts on the surface of dressed poultry are an index of the care and sanitation techniques employed. Furthermore, a low initial bacterial load insures longer keeping time when the product is held iced or in the unfrozen state.

To determine the magnitude of bacterial contamination on the surface of poultry, standardized techniques for making estimates of bacterial numbers are necessary. Such methods give the processor, handler, or researcher useful criteria with which to judge the effectiveness of the techniques he has employed, processing equipment used, or the efficiency of sanitation practices employed. Further usefulness is found in quality control and regulatory work where the efficiency of different washing techniques, potential shelf life of products, the efficiency of in-plant chlorination, or the use of antibiotics on the bacterial flora may be under study.

The growth of bacteria on poultry meat is a surface phenomenon. Unless there has been a puncture, or the interior of the meat contaminated in some mechanical way, poultry meat is of extremely low bacterial count. However, bacteria are found on the exposed surfaces and will grow to enormous populations under proper conditions. It is therefore desirable to develop methods for analyzing the surface of the meat rather than the interior or the entire piece of meat.

Existing methods. Whole dressed poultry presents large areas of intact skin and the sampling of the surface can be done by the use of swabs as described by Ayers *et al. (1)*, Gunderson *et al. (2)* or by Drewniak *et al. (3)*. Such samplings may be made on the breast, back, legs, etc.; bacterial numbers of the various surface areas can then be determined quite easily. On the other hand, when the poultry is cut up and boxed as cut-up, ready-to-cook poultry, a new situation is developed. Cut-up pieces expose areas of raw meat, some skin, bone and cartilage, and present a very irregular surface area. It is difficult to use the swab and template methods *(1, 2, 3)* and relate the bacterial count to the surface sampled.

To overcome this difficulty the method described in U. S. Department of Agriculture *Circular* 930 *(3)* was developed; namely, a "shake" technique in which the piece of chicken to be sampled is placed in a flexible film envelope, sterile water added, and the contents of the envelope or bag shaken. An aliquot of the wash water is then plated in the conventional manner for determining the numbers of bacteria. This method had many advantages—among them the washing of the bacteria from the entire surface area of the piece, ease of making the sampling, the rapidity of the technique, and the non-destructive nature of the sampling.

The major defect of this method was the difficulty of relating bacterial numbers to the surface area from which they came. Due to the extremely irregular surface, a determination of total surface area could not be made, and the bacterial numbers had to be reported per ml. of water used to wash the piece of poultry meat. Some uniformity was obtained by varying the amount of wash water according to the "size" of the piece. But unless bacterial numbers are related to some basic standard of measurement, weight, size or surface area, results mean little except for comparative purposes where nearly identical samples are taken.

Advantages of the proposed method. To correct this lack of knowledge as to the bacterial status of the surface area of each piece of chicken tested, the method presented here was developed. It was reasoned that if the approximate surface area of each piece of meat tested could be determined, then bacterial counts made on different pieces of chicken or at different locations could be compared. Also, this would simplify the reporting of results and provide a more uniform method for use both in research and in plant operations.

After several failures at determining the surface areas of very irregular objects, it was decided to use a wax impression method and from this determine not only the surface area, but the relative change in ratio of weight to surface area as the weight of the birds increased. A wax composed of equal parts of beeswax and resin was found to have many advantages in making wax impressions. Since this formulation gives a product that melts at 140° F. it is not hot enough to damage the meat in any way. Moreover, it is firm and yet plastic at room temperature; it is easily bent with the fingers when removed from the pieces of meat.

METHODS

Individual chicken parts were taken from the refrigerator and weighed to the nearest gram. A small cord was attached to the piece in a position convenient for dipping the part into the wax. The wax was heated to just above the melting point

[a] Presented at the Eighteenth Annual Meeting of the Institute of Food Technologists, Chicago, May 28, 1958.

and the part quickly lowered into the wax by means of the string. It was immediately withdrawn and held above the wax until a dull appearance indicated solidification of the wax. The dipping was repeated until a layer of wax had been built up of sufficient thickness to be removed from the piece without loss of shape.

The waxed piece of meat was cooled in running tap water, and then the wax was very carefully cut through with a sharp knife to divide the mold into two parts along the greatest dimensions and on the sides of the minimum thickness. The two halves were gently removed and placed on a board with the concave side up. It was found that by making cuts from the edge into the deepest depressions the mold could be flattened out by gentle pressure with the fingers. The small cuts allowed the wax to flatten out without wrinkling or changing shape. This procedure is illustrated in Figure 1. Difficulty in obtaining a good wax impression was encountered only with the two pieces of the back. The inside of the back is very irregular due to the nature of the bone structure and there are many deep cavities from which it was quite difficult to remove the wax without breaking it. However, with the chicken piece quite damp to prevent sticking and allowing the piece to stand at room temperature to increase the plasticity of the wax, the mold could be removed without altering the shape.

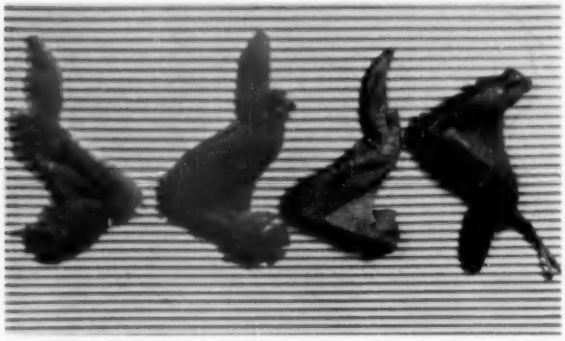

Figure 1. Procedure used to prevent wrinkling; use of small cuts to permit flattening out in making wax impressions.

Measuring. Now that the surface area of the piece of chicken was represented in the flattened parts of the wax mold, the problem became one of measuring that surface. The outline of the pieces of wax was so irregular that the use of a planograph or other type of physical measurement proved impracticable. It was finally decided to determine the surface area by weight. A large sheet of kraft paper was chosen for this purpose. Pieces of this paper were measured and cut into 200 sq. cm. portions and carefully weighed on an analytical balance to determine the uniformity of weight of pieces of equal size from different locations in the piece of paper. The variation was found to be within very narrow limits.

The pieces of wax were laid on the piece of kraft paper and the outline of the wax carefully traced with a pencil following every irregularity of the edge. The paper was then cut along the pencil line to produce a paper pattern of the wax mold. The pattern pieces of each piece of chicken were combined and weighed on the analytical balance. Taking the weights of the previously weighed 200 sq. cm. samples as the standard of weight per sq. cm. of paper, the sq. cm. area of the cut out pieces were calculated.

The above procedure was repeated for each piece of a box of commercial cut-up ready to cook chicken. Each box consisted of 10 pieces: 2 pieces of breast, 2 wings, 2 drumsticks, 2 thighs, the anterior portion of the back, and the posterior portion of the back. These measurements were then repeated for duplicate boxes of commercial cut-up ready to cook chickens for weights between 1¾ pound broilers to 4¼ pound fowl. Twelve birds were used in this series. Since these were boxes from commercial packs, it was believed that they were representative of samples to be found in commercial channels. Some variation might be expected in the exact way in which different plants make the cut in producing ready cut poultry, but these variations should be of minor importance for the purpose of establishing a mean of determining surface areas.

Regression equations for estimating the surface areas of cut up chicken pieces when weight in grams is known are:

Area of breast in sq. cm. = 137.26 + .84 × wt. in grams
Correlation: R = .94

Area of wing in sq. cm. = 85.86 + 1.41 × wt. in grams
Correlation: R = .84

Area of back in sq. cm. = 94.39 + 1.11 × wt. in grams
Correlation: R = .93

Area of thigh and drumstick in sq. cm. = 59.69 + .90 × wt. in grams
Correlation: R = .94

Since the square of the correlation coefficient is the proportion of variability in surface area accounted for by its regression on weight, this indicates that except for the wing about 90% of the variability is accounted for. On wing, about 70% of the variability is accounted for.

Confidence bands for predicted values were obtained in accordance with the method of Bennett and Franklin. Because of space limitations, these bands have been omitted.

RESULTS AND DISCUSSION

The results from the weighing of the piece of meat and the surface area obtained from the wax mold were plotted on graph paper. The weight of each piece was plotted against the surface area obtained from the wax mold.

It can be seen from the curves in Figure 2 that

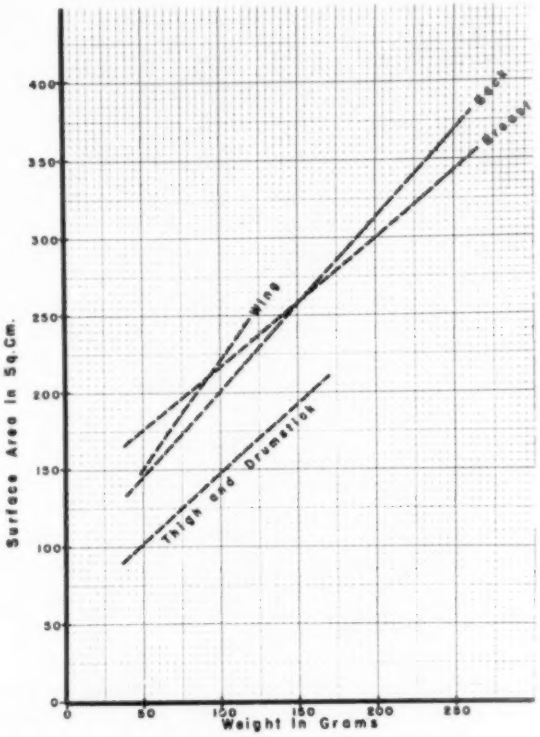

Figure 2. Chart for determining surface area of chicken parts.

there is a linear relationship between the surface area of each type of chicken part and an increase in weight of the piece. The ratio of surface area to weight of piece from small birds to large birds fall along a straight line. The slope of the lines is different for the various parts of chicken. It can be seen that the range in weights for the different size of birds is much greater for the back than for the thigh.

It was found that the posterior part of the back and the anterior part of the back could be superimposed to form a single straight line. This was found true also of the drumstick and the thigh. Accordingly, the curves constructed for Figure 2, are for the back, breast, wing and drumstick—thigh. The horizontal axis represents the weight of the piece of chicken and the vertical axis represents the surface area of the piece. To use the chart the weight of any given piece is found on the horizontal axis and projected upward to the line corresponding to the particular piece. A line is then projected from this point to the vertical axis to determine the corresponding surface area.

As pointed out earlier, the bacterial population of fresh poultry is found almost entirely on the surface and, therefore, bacterial counts should be related in some manner to the surface area sampled. As an example of how Figure 2 may be used for this purpose, the method outlined in USDA Circular 930 *(3)* and in *Recommended Methods for the Microbiological Examination of Foods*, Chapter 14 *(4)*, may be used. If a cut up piece of breast is selected, it should be placed in a sterile plastic bag or jar and approximately 3 times its estimated weight of sterile saline water measured and added. The mouth of the container is then closed and the sample shaken thoroughly. An aliquot of the "wash" water is then removed and plated in several dilutions for bacterial counting. At the conclusion of the incubation period (72 hours at 32° C.) the bacterial count is determined.

After shaking the above sample for making the bacterial count, the piece is removed and blotted to remove surface moisture and weighed to the nearest gram. For ease in presenting this example, let us assume that the piece of breast weighed 200 g. and that 600 ml. of sterile saline water were added. Through the use of Figure 2, it is determined that the approximate surface area of such a piece is 305 sq. cm. The dilution of the sample was 3 parts water to 1 part of sample. Let us further assume that there was an average of 50 bacterial colonies on the plates representitng a dilution of 1 to 10,000. The calculation would then be—

$$\frac{50 \times 10{,}000 \times 3}{305} = 4{,}918.$$

Thus, each sq. cm. of the sample tested is determined to have a bacterial count of approximately 4,920.

If the approximate surface area of the piece had not been available, it would have been necessary to relate the bacterial count to (1) per ml. of dilution water, or (2) per piece of chicken, or (3) per gram of sample. Such counts would have been (1) 500,000 per ml. of dilution water, (2), 1,500,000 for the piece or (3) 7,500 per gram of sample. Since the bacteria found were washed from the surface of the chicken part, relating the count to the surface area is representative of the condition found.

SUMMARY

A method of determining the surface areas of irregular pieces of cut-up chicken of different sizes has been presented. A chart for estimating the surface areas of different types of chicken parts from their known weights has been prepared and a method of relating microbiological results obtained by bacterial techniques to the surface of the sample from which the bacteria came has been demonstrated.

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The Compatability of Dehydrated Army Rations With Chlorinated and Iodine-Treated Ground-Waters

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THE IMPACT of radical new weapons on organizational, tactical, and logistical planning makes obsolete the existing field feeding system in forward combat areas. Under new concepts, combat troops must be capable of maximum mobility and dispersion for indefinite periods. To reduce the overall logistical problems involved in the feeding of highly mobile military forces, and to simplify the logistical support required to feed the soldier in combat areas, a system based on pre-cooked dehydrated meals appeared to offer potential answers to emergency military-subsistence problems.

With these dehydrated meals, groups of soldiers can prepare their food simply by adding water. No heavy equipment or trained food service personnel is needed; only water and, in certain instances, a source of heat are required. Disposable trays and utensils packaged with the meals eliminate the need for washing mess gear, reducing the need for water to only that needed to reconstitute the dehydrated foods and for individual consumption *(2)*.

With increased emphasis on dehydrated foods, the requirement for potable drinking water to be used in reconstituting these foods is apparent. The stated doctrine of the Armed Forces, as given in TM 5-295, "Military Water Supply and Purification," is that the following rules will be used as a guide in the selection of water *(3)*.

"(1) In populated areas, use established public systems to the fullest extent.

"(2) Use existing springs or wells next. The quality of water from these sources is usually better than from surface sources.

"(3) If public or ground water sources are not readily available, use surface water sources such as rivers, streams, lakes or ponds.

"(4) When other sources are not available, dig wells to use ground-water sources. Development of new ground-water sources is not practical for any Army on the move. For rear echelon units, a ground-water source is usually best, especially in areas where surface water sources are highly contaminated as in China, the Philippines, India, Japan, and other parts of Asia.

"(5) As a last resort, when no fresh-water source can be found, use distillation units to purify sea water.

"(6) In cold climates melt snow and ice to obtain water in limited quantities. This practice is made necessary where other sources are polluted or where conventional sources cannot be located.

"(7) Under special conditions, where surface water is almost totally lacking, and means are not available for developing ground-water sources, rainwater catchment basins can be improvised to obtain limited amounts of water."

Although the Corps of Engineers will normally supply the water needs of the soldier in combat areas, it takes time, skill, and equipment to process water and have it available at all times under all conditions of combat mobility and dispersion. Under certain emergency conditions troops in the field will utilize whatever water is most readily available, regardless of the source. Since dehydrated food rations are available in either individual units as meal packets or as a complete ration for as many as 25 men, the soldier in the field may, under certain circumstances, depend upon his own resources to obtain the necessary water required to reconstitute these emergency dehydrated rations. The first requirement facing the soldier is that of making certain that the water to be used in rehydrating the dehydrated food under emergency field conditions is free from water-borne pathogens such as typhoid, cholera, amoebic cysts, viruses, etc. For individual canteen quantities of water, this is best accomplished by using the standard iodine tablet as the disinfecting agent *(7, 8)*. Powdered calcium hypochlorite is used as the source of chlorine for disinfecting larger volumes of water such as contained in 35-gallon Lyster bags *(4, 5)*.

Water-disinfecting compounds, in addition to being efficient germicides, must be acceptable to the users for whom they are intended. Since troops living under adverse field conditions are extremely critical of any added inconveniences, it is therefore desirable that water sterilizing compounds be free from unpalatable tastes and odors when used with various types of waters, and impart no objectionable taste or odor to the reconstituted dehydrated foods used in the field.

Since it is a daily responsibility of the Quartermaster Corps to provide food for the soldier and also to provide a means of purifying small quantities of water (up to 35 gallons) under emergency field conditions, this study was undertaken to insure that such waters will have application to the reconstitution of dehydrated foods utilized under the simplified feeding program. The dehydrated foods employed in this study are representative food components from experimental rations found to have high soldier acceptability. The present study is limited to the compatability of dehydrated foods with five chlorinated and iodine-treated raw waters which serve as examples of waters of high mineral concentration that might be available to the soldier in times of emergency.

EXPERIMENTAL

Materials. Three types of dehydrated foods were used for screening purposes in this study. They included: hot cocoa beverage powder, hot cream of onion soup, and cold orange juice powder, synthetic, Type I, with ascorbic acid. Hot soluble tea product was also used in one set of tests with water high in iron content and a few preliminary experiments were also conducted on pre-cooked-dehydrated soup and gravy base, diced sweet potato, mashed white potato, snap green beans and ground beef. Five ground waters representative of high mineral concentration were received from the following sources: Midland, Texas (high in mineral content); Elizabeth City, N. C. (high in iron content); Ames, Iowa (high in iron content); Washington, N. C. (high alkalinity and iron content); and Sarasota, Florida (high in sodium content).

The standard iodine tablet used in these tests contains 19.3 to 21.3 mg. of tetraglycine hydroperiodide, 82.5 to 92.3 mg. of sodium acid pyrophosphate and up to 6.0 mg. of talc. One iodine tablet when dissolved in a canteen (1 quart) of water yields an average of 8.0 mg. of iodine *(7)*. Each glass tube contains 0.45 to 0.55 g. of calcium hypochlorite and is sufficent to disinfect one Lyster bag (30 to 35 gallons of water) at a concentration of 1 mg./l. chlorine *(4, 5)*.

Methods. Chemical analyses of all the waters used in this study were carried out in accordance with the procedures outlined in *Standard Methods for the Examination of Water, Sewage, and Industrial Wastes (1)*. For the comparison of tastes and odors of halogen-liberating compounds, it became necessary to adopt parameters or yardsticks which would reflect the reactions of the olfactory and taste senses. A laboratory taste panel consisting of 7 untrained tasters was formed to predict the relative acceptance of dehydrated foods reconstituted with chlorinated and iodine-treated raw ground waters. The hedonic scale *(9)* provided the criteria for these evaluations.

Each member of the taste panel was given a hedonic scale form similar to the one shown in Table 1 and asked to employ this scale to indicate his attitude toward each sample by checking at the point on the scale which best described his feeling about the taste and odor of each food sample. Each subject rated each of the 3 dehydrated foods (hot cocoa beverage powder, hot cream of onion soup, and cold orange juice powder, synthetic, Type I) first reconstituted with distilled water containing 0, 8, 16, and 24 mg./l. iodine and 0, 1, 5, and 10 mg./l. chlorine. Each test was then repeated but this time the raw ground water under investigation was substituted for the distilled water. The hedonic ratings assigned each food by the panel members were tabulated and the median value obtained for comparative purposes. Each subject made 4 judgments at a sitting and no more than 2 sittings per day was asked of a subject.

TABLE 1

Hedonic scale form used for laboratory preference tests

Taste	Odor	Corresponding numerical values
Like extremely	Like extremely	9
Like very much	Like very much	8
Like moderately	Like moderately	7
Like slightly	Like slightly	6
Neither like nor dislike	Neither like nor dislike	5
Dislike slightly	Dislike slightly	4
Dislike moderately	Dislike moderately	3
Dislike very much	Dislike very much	2
Dislike extremely	Dislike extremely	1
Comments	Comments	

The raw ground-water control sample (containing no halogen) before being used in each test was first filtered through a Seitz filter to remove any possible pathogenic organisms that might be present. All other raw-water samples were rendered potable by the addition of either iodine or chlorine prior to being used in the reconstitution of the dehydrated foods. Several concentrations of both iodine and chlorine were evaluated. Although in the majority of instances the addition of one iodine tablet (8 mg. iodine/l. of raw clear water) and the maintenance of 1 mg. of residual chlorine per liter of raw clear water are the recommended dosages for emergency water disinfection, higher concentrations of these halogens may be needed for highly colored and very cold waters. Consequently, concentrations of 16 and 24 mg. of iodine per liter of water and 5 and 10 mg. of chlorine per liter of water were also evaluated.

Conditions such as the temperature, quantity of sample, and concentration were all controlled. Each food was reconstituted in accordance with the directions on the package of the dehydrated foods tested. Each member of the sensory panel was served 20 to 25 ml. portions of each food for evaluation. Hot cocoa beverage powder and hot onion soup were served at about 80° C. (176° F.) and the cold orange juice powder was served at about 5° C. (41° F.).

RESULTS AND DISCUSSION

The 1946 U. S. Public Health Service Standards for Drinking Water have become the recognized guide to public water-supply quality. Since it is impractical to control the quality of the water supply for temporary, emergency use other than being certain that the water is free from pathogenic organisms, a question of more immediate concern is: What are the allowable deviations from these accepted minimum standards?

Table 2 compares the suggested U. S. Public Health Standards for Drinking Water with the results of the chemical analyses of the ground waters under consideration.

In most instances the limitations on the chemical constituents of water are based on physiological reactions as well as on the imparting of undesirable tastes and odors to the water *(10)*. Some of the more common constituents and conditions of natural water supplies include hardness, chloride, iron, sulphates, and total solids. Hardness in water is produced by calcium and magnesium. It is generally considered that hard water is not injurious to health. However, temporary use of waters containing magnesium in excess of 125 mg./l. will produce a pronounced laxative effect. Presence of chlorides in water in excess of approximately 250 mg./l. imparts a salty or brackish taste to the water for some persons while to others 500 mg./l. are not noticeable. Limitations on chlorides are for reasons of palatability rather than health. The accepted standards for drinking water limit the concentrations of iron and manganese to 0.3 mg./l. mostly because of the undesirable reddish appearance imparted to the water and the palatability of the water rather than health considerations. The concentration of sulphates in excess of the recommended 250 mg./l. may be used constantly without adverse effects. Temporary use of water with high sulphate content will induce laxative effects in some persons just as magnesium does. Total solids concentration in excess of 1000 mg./l. will likewise induce a laxative effect. Other salts found in polluted waters are not generally a problem in natural waters, and were therefore not considered in the chemical analysis of the ground-water.

During emergency conditions, ground waters of such mineral concentration (as reported in Table 2)

greater than is recommended by U. S. Public Health Standards for drinking water will have to be used without the benefit of any water softening treatment for reconstituting dehydrated foods. Tables 3 and 4 list the average hedonic ratings assigned to 4 dehydrated foods reconstituted with five such iodine-treated and chlorinated ground waters.

Results of the reconstitution of the cocoa beverage powder as shown in Table 3 indicate that the panel rated the *Midland water* at the highest concentration (24 mg./l.) of iodine slightly below the equivalent amount of iodine in the distilled water, both being in the *like moderately* range. The odor rating at the highest concentration of iodine showed the Midland

TABLE 2

Comparison of U. S. Public Health suggested limits of mineral content for drinking water with mineral content found in five raw ground waters

Constituent	U.S. Public Health suggested maximum limits mg./l.	Cole Park Field Well no. 1 Midland, Texas	Shallow wells Elizabeth City, N. C.	Well no. 5 Ames, Iowa	Well no. 4 Washington, N. C.	Pooled well fields Sarasota, Florida
Magnesium	125	205	10	14	20	117
Iron	0.3	.....	18	6.6	2.0	0.39
Chloride	250	762	11	6.1	125	173
Sulphate	250	1250	39.5	143	19	833
Total alkalinity	35–60**	335	160	297	345	130
Total solids	1000	3580	*	508	629	1724
Precipitate formed upon the addition of Iodine	.....	yes	no	yes	yes	yes
Total hardness	100**	1490	166	398	149	1083
Color	20**	*	*	10	10	5
pH	no suggested limit	7.4	7.3	7.4	7.7	7.2
Date sampled		April 9, 1956	July 16, 1956	August 21, 1956	January 7, 1956	March 5, 1957

* Not analyzed because of insufficient sample.
** Not U. S. Public Health limits, but suggested standards for good quality drinking water *(10)*.

TABLE 3

Average hedonic ratings for reconstituted dehydrated foods with iodine-treated ground waters

Dehydrated food tested		Distilled water Iodine mg./l.				Midland, Tex. Iodine mg./l.				Elizabeth City, N.C. Iodine mg./l.				Ames, Iowa Iodine mg./l.				Washington, N. C. Iodine mg./l.				Sarasota, Florida Iodine mg./l.			
		0	8	16	24	0	8	16	24	0	8	16	24	0	8	16	24	0	8	16	24	0	8	16	24
Cocoa beverage powder	Taste	8.1	8.0	8.0	7.0	*	7.6	7.7	7.6	8.0	7.9	7.0	7.7					8.0	6.1	7.0	7.3	7.9	7.7	7.7	7.9
	Odor	8.1	7.7	7.3	7.9	*	7.6	7.1	6.9	8.0	8.0	8.0	8.0					7.6	6.9	7.4	6.9	8.0	7.9	7.9	7.9
Orange juice synthetic type I	Taste	7.4	6.4	6.7	7.3	*	7.0	6.7	6.1	7.1	3.1	6.3	5.9					7.0	6.6	7.0	6.1	7.1	7.1	7.0	6.3
	Odor	7.4	7.3	7.3	7.3	*	7.6	7.3	6.9	7.3	3.9	6.4	7.4					7.1	7.3	7.1	7.1	7.3	7.0	7.0	6.6
Cream of onion soup	Taste	7.9	7.7	7.4	7.4	*	6.9	7.1	7.1	7.9	7.3	7.7	7.7	5.8	5.2	5.5	5.3	7.7	7.7	7.4	7.0	7.9	7.4	7.7	7.6
	Odor	7.4	7.9	8.0	8.0	*	8.1	7.3	7.3	7.4	6.7	7.4	7.4	7.0	6.8	7.0	7.0	7.7	7.7	7.6	7.6	7.9	7.7	7.6	7.7
Soluble tea product	Taste	5.9	5.0	5.3	5.7																				
	Odor	6.7	6.0	6.4	6.6																				

Hedonic Scale
9—Like extremely
8—Like very much
7—Like moderately
6—Like slightly
5—Neither like nor dislike
4—Dislike slightly
3—Dislike moderately
2—Dislike very much
1—Dislike extremely

* Not tested because of insufficient sample.

TABLE 4

Average hedonic ratings for reconstituted dehydrated foods with chlorinated ground waters

Dehydrated food tested		Distilled water Chlorine mg./l.				Midland, Tex. Chlorine mg./l.				Elizabeth City, N.C. Chlorine mg./l.				Ames, Iowa Chlorine mg./l.				Washington, N. C. Chlorine mg./l.				Sarasota, Florida Chlorine mg./l.			
		0	1	5	10	0	1	5	10	0	1	5	10	0	1	5	10	0	1	5	10	0	1	5	10
Cocoa beverage powder	Taste	8.1	7.9	8.0	8.0	*	7.2	7.6	7.1	8.0	7.1	6.6	6.9					8.1	7.6	8.0	7.9	8.1	8.0	7.7	8.1
	Odor	7.9	8.1	8.0	8.0	*	7.0	7.0	7.9	8.0	8.0	7.7	7.9					8.1	7.4	7.7	7.9	8.1	8.0	7.9	7.9
Orange juice synthetic type I	Taste	7.4	7.4	7.3	6.4	6.6	6.7	6.4	7.1	7.1	7.3	5.0	4.7					7.0	6.0	6.1	5.4	7.3	5.8	6.5	6.1
	Odor	7.4	7.4	7.3	7.0	8.8	7.6	7.7	7.3	7.3	7.3	6.4	6.6					7.1	7.0	6.7	6.9	7.5	7.3	7.2	7.0
Cream of onion soup	Taste	8.2	8.0	7.9	8.0	7.3	7.4	7.9	7.7					8.1	8.0	7.4	8.0	7.6	6.4	7.1	6.4	8.2	8.0	7.9	8.0
	Odor	8.2	8.1	7.9	8.0	8.0	8.0	8.0	7.7					8.1	8.0	7.0	8.0	7.6	6.9	7.1	5.6	8.2	8.1	7.9	8.0
Soluble tea product	Taste	5.6	4.7	4.7	3.9									5.7	4.1	4.6	3.7								
	Odor	6.0	6.0	5.9	5.0									5.9	5.1	5.3	4.3								

Hedonic Scale
9—Like extremely
8—Like very much
7—Like moderately
6—Like slightly
5—Neither like nor dislike
4—Dislike slightly
3—Dislike moderately
2—Dislike very much
1—Dislike extremely

* Not tested because of insufficient sample.

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water was just below the *like slightly* (6.9) range while the odor rating for the equivalent amount of iodine in the distilled water was rated *like moderately* (7.9). It was noted that when the iodine tablets were added to the Midland water, a flocculent white precipitate resulted, but did not occur with distilled water. To check the possible cause for this reaction, 87 mg. of sodium acid pyrophosphate (buffer used in the iodine tablet, alone was added to 1 liter of Midland water. The same flocculent precipitate resulted with the Midland water but did not occur with the distilled water. It was found that a precipitate would form with any water as a result of adding an iodine tablet to water containing a minimum of 25 mg./l. of calcium bicarbonate. However, approximately 50 mg./l. calcium bicarbonate are essential before the precipitate becomes so pronounced that it may be cause for an individual to refuse to drink the water because of its cloudy appearance. The presence of this precipitate was readily masked when the water was used to reconstitute the cocoa beverage powder and did not appear to affect the consistency or appearance of the reconstituted cocoa.

With the reconstitution of the cocoa beverage powder using chlorinated Midland water (high mineral water) the results in Table 4 showed that the Midland water was not as acceptable as the distilled water at any concentrations of the chlorine, but was still within the *like moderately* category for both taste and odor. However, it was noted that the Midland water had some effect on the color and consistency of the reconstituted cocoa. The Midland water made a lighter colored cocoa (not objectionable) and caused some solid material to coagulate and precipitate out of solution after the cocoa beverage powder was reconstituted. However, no precipitate was evident when the calcium hypochlorite was added to Midland and distilled waters alone before the addition of the cocoa.

In the case of the orange juice powder, synthetic, Type I, at 8 mg./l. of iodine, the average rating placed the Midland water in both taste and odor slightly above the distilled water. At 16 mg./l. of iodine, both the distilled and the Midland waters were rated equally in the *like slightly* class for taste and *like moderately* for odor. However, as 24 mg./l. was reached, the ratings were reversed so that the distilled water was preferred *(like moderately)* over the Midland water *(like slightly)*.

With the reconstitution of orange juice, synthetic, Type I, with the Midland water at all concentrations of the chlorine including the control (no chlorine), the orange juice was given an average rating of *like slightly* for taste but a higher rating for odor. As the chlorine concentration increased from 0 to 10 mg./l. a corresponding slight decrease in odor acceptance was noted from an average rating of 8.8 (control-absence of chlorine) to 7.3 (10 mg./l. chlorine).

Results of the sensory ratings of cream of onion soup indicate the soup masked the taste and odor of the iodine, although the cream of onion soup reconstituted with distilled water received a slightly higher rating than soup with the Midland water. Both the distilled and Midland waters used in the reconstitution of the cream of onion soup were on the average rated in the *like moderately* category. No apparent differences in color, appearance or consistency were detected in the rehydrated samples.

Reconstitution of orange juice, synthetic, Type I, with *Elizabeth City* water treated with 8 mg./l. of iodine resulted in considerably lower taste and odor ratings than for the comparable controls. This difference was not quite so evident at 16 and 24 mg./l. of iodine, probably as a result of the 8 mg./l. of iodine sample being tasted first by each member of the taste panel. As the other samples were tasted, deterioration in taste perception probably developed, as has been shown by MacLean and Wickens *(6)* when several samples of cocoa were tested at a single session.

Results of reconstituting dehydrated foods with chlorinated Elizabeth City water (high in iron content) in general produced acceptable products with the exception of orange juice, synthetic, Type I. Reconstitution of orange juice powder, synthetic, Type I, with chlorinated Elizabeth City water produces a drink which was given the following taste ratings: at 1 mg./l. chlorine—*like moderately;* at 5 mg./l. chlorine—*neither like nor dislike;* at 10 mg./l. chlorine—*dislike slightly.*

The *Ames water* was selected as a second source of water high in iron content to ascertain if any off-flavor or off-color resulted from the possible formation of iron tannates with dehydrated soluble tea product. In general soluble tea product was not well received by the taste panel. The controls (no chlorine or iodine) for both the Ames water and the distilled water were taste rated in the *neither like nor dislike* category. The presence of iodine up to 24 mg./l. did not appear to affect the general taste rating assigned to this product. However, as the chlorine was increased from 1 to 10 mg./l., in both the Ames water and distilled water, the taste rating dropped from *dislike slightly* to *dislike moderately.* Chlorine appeared to have a greater adverse effect on soluble tea product than did iodine. These results indicate iodine-treated Ames water containing 6.6 mg./l. of iron has little effect on the taste-odor acceptability of soluble tea product. The addition of chlorine to the Ames water under the same test conditions had some adverse effect on both taste and odor. The chlorinated Ames water was also used to reconstitute the cream of onion soup. Taste and odor ratings were all in the *like very much* category except at the 5 mg./l. chlorine level, when both the taste and odor ratings were lowered to the *like moderately* category.

Water from *Washington* was found to be high in both alkalinity and iron content, and formed a slight cloudy precipitate upon the addition of an iodine tablet. The only foods which showed a slight decrease in taste or odor acceptability were the dehydrated foods reconstituted with chlorinated water from this source and included orange juice, synthetic, Type I, and cream of onion soup. With the orange juice, as the chlorine concentration increased from 1 to 10

mg./l., the taste acceptability went from *like slightly* to *neither like nor dislike*.

In the case of cream of onion soup, as the chlorine concentration went from 1 to 10 mg./l., the odor acceptability went from *like slightly to neither like nor dislike*.

Water high in sodium content was received from *Sarasota*. The only food item where there was a slight decrease in taste acceptability was orange juice, synthetic, type I, when this chlorinated water was used. Taste ratings from *neither like nor dislike* to *like slightly* were assigned this sample vs. the control which had an average taste rating of *like moderately*.

SUMMARY AND CONCLUSION

Four pre-cooked dehydrated foods were reconstituted with five sources of ground water exceeding the maximum levels of mineral concentration recommended by the U. S. Public Health Service Standards for Drinking Water. These waters were rendered potable by the addition of iodine or chlorine prior to use in the reconstitution of the dehydrated foods. The three screening foods were taste-odor-tested by a panel of seven untrained members.

The sensory panel used the hedonic scale for scoring both taste and odor and recorded their comments on any marked differences in flavor and odor acceptability as well as the appearance of each reconstituted food. Results were presented in terms of the mean hedonic scale ratings.

From these, it may be concluded that the emergency use of iodine-treated and chlorinated ground waters of the compositions tested impart no serious objectionable taste or odor to the precooked dehydrated foods tested.

Current studies include the sensory evaluation of chlorinated and iodine-treated surface-type waters obtained from various U. S. sources using the same three screening dehydrated foods. Results of these experiments will be reported later.

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Use of Grade Standards in the Quality Control of Fishery Products

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THE TOTAL CATCH of food fish and of industrial fish taken in 1957 was approximately five billion pounds. This catch afforded employment for about 150 thousand fishermen and about 100 thousand other people in transporting, wholesaling, and manufacturing. Of the total catch, about 2½ billion pounds of food fish and shellfish was landed, of which almost 1½ billion pounds was sold either fresh or frozen.

The ease of marketing the large quantity of food fish and shellfish landed depends on consumer acceptance, which, in turn, depends largely upon the quality of the product. Fish and shellfish possess characteristics that tend to make the maintenance of quality somewhat more difficult than is the case with other protein foods. The difficulties are these:

1. Fish is a product of an uncontrollable environment quite the opposite of the environment of domestic animals.
2. The bacterial population indigenous to fish and shellfish is adapted to growth at lower temperatures than are the bacterial populations of warm-blooded animals.
3. Processing plants often are located long distances from the source of supply; therefore long preprocessing storage periods sometimes may be necessary.
4. Much care is needed in fishing and processing procedures to avoid bacterial contamination of the product.

Modern transportation and processing methods and the introduction of "convenience" items have increased consumer demand and opened new markets for fishery products. Producers and processors of fish realize that to maintain or to increase marketing opportunities further they must supply a product of consistently good quality and that, accordingly, gives rise to repeat demand. To aid the industry in this objective, the Bureau of Commercial Fisheries of the U. S. Department of Interior is cooperating with processors and producers in a program of standards development.

There are five standards for grades of fishery products now in effect: (1) Frozen Fried Fish Sticks, (2) Frozen Fish Blocks, (3) Frozen Raw Breaded Shrimp, (4) Frozen Haddock Fillets, and (5) Frozen Halibut Steaks. The last two standards are newly promulgated, both became effective in March 1959. Two additional standards for frozen fish are being prepared at the laboratories of the Bureau of Commercial Fisheries: one for cod fillets at our Boston laboratory and one for salmon steaks at our Seattle laboratory. Quality factors that may be used in developing standards for iced raw headless shrimp and frozen raw headless shrimp are being studied at our College Park laboratory.

Standards for Frozen Fried Fish Sticks have been in effect since August, 1956. At the present time, six processors producing over 25% of the total output have continuous inspection. Inspection service for frozen fish blocks and frozen raw breaded shrimp began on July 1, 1958. At present, ten processors of breaded shrimp have continuous inspection. Their output comprises over 70% of the total breaded shrimp produced.

The three voluntary standards for grades now in effect were promulgated at the request of and with the cooperation of the processors. In developing these standards, every effort is made to consider processing difficulties. The purpose of the present report is:

1. To explain how a processor may have the grade standards applied to his product.
2. To list the requirements that must be met in the standards.
3. To point out the benefits derived.

HOW GRADE STANDARDS ARE APPLIED

Use of fishery-product-grading-and-inspection service is entirely voluntary on the part of the producer. Two general types of service are available. The first is inspection of a separate lot, for which a certificate of quality and condition is issued but for which grade labeling is not permitted. However, the processor using lot inspection may label the product with the statement: "This package is one of a lot from which samples have been inspected by the U. S. Department of the Interior." The second type of service is continuous in-plant inspection and grading, which allows the processor to indicate on his package the grade assigned to the product.

A processor who wants continuous inspection in his plant makes application to the Bureau of Commercial Fisheries in Washington, D. C. Prior to acceptance of the plant by the Bureau, a preliminary survey is made to determine the potential adequacy of the plant to produce a quality product. Proper temperatures for raw materials and product must be maintained, for example, and speed in handling at all stages of processing is important. The building and equipment must be so constructed and arranged as to provide for both prompt handling of food materials and ease of cleaning. Any major physical deficiencies or unsanitary practices must be remedied, and necessary minor changes must be made within a reasonable time. These requirements do not in any way conflict with, or

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replace, existing sanitary requirements of the Food and Drug Administration or of the Public Health Service.

After an inspector has been assigned to a plant, part of his duties are to see that satisfactory sanitary conditions and practices are maintained. Inspection for grade standards is always made on the finished product, which in the case of frozen fishery products, requires a lapse of time sufficient for freezing. The inspector must therefore be alert to variations in quality of the incoming raw materials and to processing variables that might result in unacceptable quality of the finished product. The processor operating under continuous inspection has available in the inspector an experienced man to supplement his own quality-control staff.

REQUIREMENTS OF STANDARDS

The requirements of standards can be considered from 2 aspects: the general requirements that all standards must meet, and the specific requirements that each individual product must meet.

General requirements of standards. Requirements for certain quality factors are common to all standards. As far as possible, the various quality factors are rated objectively by a numerical scoring system based on 100 points as the highest number attainable. Factors relating to appearance, uniformity, and absence of defects of workmanship are given a numerical score. The magnitude of the score points assigned to the various quality factors reflects the relative importance of each factor to the overall quality and consumer acceptance of the product.

Flavor and odor are considered to be equal in importance to the combined factors that are rated numerically. In fact, a subjective rating of *good* for flavor and odor is necessary for a Grade A product, and a rating of *reasonably good* is necessary for a Grade B product, regardless of the numerical score assigned.

Specific requirements for individual products. In the following subsections the specific requirements for frozen fried fish sticks, frozen fish blocks, and frozen raw breaded shrimp will be discussed.

Requirements for Frozen Fried Fish Sticks. The first standards for grades of any fishery product were for fish sticks. Fish stick processing, a new industry with a production of 7½ million pounds in 1953, has developed until 44½ million pounds were produced in the first 9 months of 1958.

Many of the factors rated numerically in grading fish sticks refer to the components of the product other than the fish. However, no specifications are made as to the type of breading or cooking oil used by the manufacturer. The choice of breading and cooking oil is limited only by the necessity of producing a coating (1) that after cooking, has good texture, good flavor and odor, uniform color, and only slight oiliness and (2) that adheres smoothly and continuously to the fish flesh.

When inspection of fish sticks began, some plants were experiencing difficulty with the adherence of the coating. Changes in formulation and processing made possible the production of a more acceptable product that could be marketed as Grade A. Bones occurring in the fish blocks from which the sticks are made also constituted a major problem at that time. This problem was overcome when the producers of fish blocks realized that more careful workmanship was necessary.

Requirements for Frozen Fish Blocks. Haddock, cod, and ocean perch are the species of fish most often used in making fish blocks. These blocks are prepared by carefully packing boneless and skinless fillets in a waxed kraft fiberboard box. The thick portion of the fillet is placed adjacent to the edge of the container, and the center depression is then built up with more fillets. Freezing under compression forces the expanding fish flesh to fill all portions of the container and to fuse together into a single block of flesh. The few plants manufacturing fish blocks in this country produced about 1½ million pounds last year as compared to 50 million pounds imported, mostly from Canada and Iceland. Since in-plant inspection abroad is not possible, the standards will be used largely as a basis for lot inspection of the imported product. These blocks are used as an intermediate product in the manufacture of fish sticks.

In the standards for grades of frozen fish blocks, uniformity is an especially important factor. If a block is not uniform, it must be trimmed in order to produce straight, uniform fish sticks. This results in loss of raw material and less fish sticks from the block. Therefore the blocks must conform to the dimensions specified by the buyer, and more than minor deviations from declared dimensions and rectangular shape result in deduction of score points.

Requirements for Frozen Raw Breaded Shrimp. The breaded shrimp industry has developed in the last 8 years. Unlike fish sticks, most of the frozen breaded shrimp are packaged uncooked, although there are some precooked breaded shrimp on the market. Thirty-three million pounds of frozen raw breaded shrimp was marketed in 1957.

The procedures for evaluation of flavor and odor for the grade standards of frozen raw breaded shrimp are somewhat different from those used for the other 2 standards. Flavor and odor of breaded shrimp are evaluated as acceptable or nonacceptable on a cooked sample. Any abnormal flavors and odors due to spoilage of the shrimp, moldiness of the breading, or off-flavors acquired by contamination are evaluated as nonacceptable, and the product cannot be graded above Substandard. No subjective division as to acceptable flavor and odor is made between Grades A and B because extensive laboratory examination of commercial packs indicates that a satisfactory differentiation between grades results from the application of the scoring system for those factors rated by score points.

The importance of a given factor to the quality of a product may vary with the end use of the product. The uniformity of size of breaded shrimp, for example, is of much greater importance to a restaurateur than to a homemaker. Accordingly, the method of scoring this factor is more stringent for an institutional pack than for a retail pack.

Grading of the degree of deterioration and the amount of dehydration must be strict, for these factors reflect the quality of the shrimp itself and are the most important ones in distinguishing between Grades A and B. With in-plant continuous inspection, however, the grading of these factors should be only a check, for efficient operation requires that the quality of raw material be determined prior to processing and packaging.

BENEFITS DERIVED

Many examples can be given of specific benefits derived from the application of fishery products standards. The new Standards for Frozen Fish Blocks will control the quality of an intermediate raw material. The fish stick processor will be able to obtain blocks of known quality, which, in turn, will reduce his problems of quality control.

When fish sticks were first produced, they became very popular. A decline in demand followed, which was related to the inconsistent and wide variation in the quality of product on the market at that time. Shortly thereafter, at the request of industry, the U. S. Standards for Grades of Frozen Fried Fish Sticks were promulgated, and inspection services were made available. Widespread acceptance of the standards and inspection services by the industry was largely credited for the increased demand for frozen fried fish sticks that is now taking place.

All standards for grades contain a description that defines the product acceptable for grading. The product definition for fish sticks, for example, requires at least 60% by weight of fish flesh in the finished product. The requirement for frozen raw breaded shrimp is 50% by weight of shrimp material. This assures the buyer, either food broker or homemaker, of a more consistent product which contains a reasonable amount of the basic fish ingredient. Grade

standards are usually incorporated as part of Federal specification requirements for purchasers of fishery food products for Government use. Effective utilization accordingly is made of existing Federal inspection services for Federal procurement of fishery products.

One major benefit from the application of standards is to assist in more effective marketing. The packed-under-continuous-inspection seals and grade labels are well known to the consumer. In sales promotions, in advertising, at point of sale, and in product use demonstrations these Federal inspection symbols can engender favorable consumer response and confidence. Marketing programs can be adjusted to specific consumer demands.

The standards for grades contain criteria and procedures that can be used by any processor to evaluate his own products and to improve his product quality control. Based upon the experience of other food industry groups, it may be expected that the development of standards will result in more uniformly satisfactory quality and in markedly increased sales for a wide variety of fishery products.

Preservation of Fruit Products by Sodium Sorbate and Mild Heat[a]

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(Manuscript received June 26, 1958)

SORBIC ACID has been used to preserve a variety of food products. Recent investigations by Salunkhe *(5)*, Ferguson and Powrie *(2)*, and Weaver, Robinson and Hills *(6)*, have shown that sorbic acid or sodium sorbate was effective for inhibiting yeast fermentation in unpasteurized apple juice (cider). Spoilage was usually due to the inability of sorbate to control bacterial growth.

The minimum conditions for pasteurization of apple juice were studied by Cruess, Aref, and Irish *(1)*. They found that all cells in apple juice were killed in ten minutes at 134° F. Other investigators report somewhat higher temperatures as being required. Pederson and Beavens *(4)* found that when the juice attained 154° F. (fourteen minutes come-up time) all microorganisms had been destroyed. More recently Marshall and Walkley *(3)* using inocula of isolated apple juice microorganisms found that a holding time of five or ten minutes at 145° F. (including a 20 minute come-up time) was required for sterilization. All of these heat treatments are considerably in excess of the conditions used in this study.

The present study is an investigation of the preservation of apple juice, peach slices, and fruit salad (pineapple and citrus slices) subjected to temperatures of 100° F. to 130° F. for five minutes in the presence of sodium sorbate. Fruit products stabilized in this manner could be stored for several weeks at room temperature with little change in flavor.

MATERIALS AND METHODS

Sodium sorbate was used throughout this study in place of sorbic acid because of the difficulty of dissolving the latter in cold fruit juices. The sodium sorbate solution was prepared from a purified grade of sorbic acid by neutralizing to pH 8 with sodium hydroxide, and adjusting to 25% concentration.

Cider samples were obtained from a local cider mill. The freshly pressed cider was pumped into a 500-gallon tank located in a refrigerated room held at 40° F. Cider samples were taken from the tank immediately after it was filled; and then sufficient Pectinol 5B and sodium sorbate were added with stirring to give final concentrations of 0.2 pound per 100 gallons and 0.06% respectively. The treated cider was allowed to settle in the cold room for 48 hours and then the supernatant liquid was decanted and heated to 120° F. in a heat exchanger. The heated material was put into bottles, which were then capped, and allowed to cool in air. Samples for plate counts, flavor evaluation, and storage tests were taken just prior to and after heating. The above experiment was repeated on five different batches of cider.

Fruit salad was prepared in the laboratory from fresh fruit purchased from a local food market. The oranges, grapefruit, and pineapples were peeled and cut into small pieces, covered with dry sugar (10% by weight) and the mixture allowed to stand in the refrigerator for 48 hours. Then the juice was removed from the solids. A concentration of 0.12% of sodium sorbate by weight was added to the juice, giving a final concentration of 0.048% based on net contents of juice and solids. This experiment was repeated at a later date and similar results were obtained.

The sections were placed in wide-mouthed containers and the juice proportioned out between them. The filled containers were heated to 120° F. for 5 minutes, capped, and cooled in a water bath.

[a] Presented at the Eighteenth Annual Meeting of the Institute of Food Technologists, Chicago, Illinois, May 26, 1958.

[b] Eastern Utilization Research and Development Division, Agricultural Research Service, United States Department of Agriculture.

The peach slices were also prepared in the laboratory, using fully matured fruit of 2 varieties, Newday and Jubilee. Skins were removed by immersing the fruit in boiling water for one minute and then slipping off the skins. The pits were removed and the peaches cut into ¼ inch slices. Twelve ounces of slices were put into each container along with 4 ounces of a 60° Brix syrup. Sufficient sodium sorbate was added to the containers to give a final concentration of 0.12% by weight on the basis of 16 ounces net contents. The prepared samples were heated, capped, and cooled in a water bath. Enough peach slices were prepared from each variety to provide 4 jars for each experimental treatment.

Nutrient agar was used to determine the number of bacteria in the different samples and "Difco" wort agar to determine the number of yeasts and molds. The numbers reported in the tables are the average number of cells found on duplicate plates which had been incubated at 86° F. for 72 hours.

The flavor of the cider was evaluated by a 10-member laboratory taste panel at each plating date. The treated material was compared with fresh, untreated, frozen cider from the same pressing. The standard "Triangle Test" was the method used for the flavor evaluations.

RESULTS AND DISCUSSION

The number of microorganisms encountered in commercially prepared fruit products will vary widely depending upon the sanitary conditions of the plant, the condition and type of raw material, and the season of the year. The microbial counts of the materials used in these experiments are thought to be fairly representative for these products. In the first experiment, the cider contained 460,000 yeasts and molds and 520,000 bacteria immediately after pressing. Table 1 shows the plate counts that were obtained after the sorbate and Pectinol had been added and the cider allowed to settle for 48 hours. It is interesting to note the difference obtained in the plate counts of the cider immediately after pressing and those obtained after it had settled for 48 hours. This decrease is thought to be due chiefly to the inhibitory effect of the sodium sorbate in the juice, although it is possible that part of this decrease was due to sedimentation.

The overall storage life of cider preserved by sorbate and mild heat was increased nearly threefold over cider treated with sorbate alone. And the increase was over 10-fold when comparing it with the completely untreated cider stored at room temperatures. Similar results were obtained with the other batches of cider.

TABLE 1

Effect of mild heat and sodium sorbate on apple cider stored at 73° F.

Treatment	Days storage	Cells per ml.[1]		Remarks
		Wort	Nutrient	
Sodium sorbate[2]	0	135,000	175,000	Good flavor
	5	250,000	210,000	Good flavor
	9	.....	.....	Gas formation
Heat alone[3]	0	22,000	27,000	Good
	6	.....	34,000	Fair
	12	.....	.....	Gas formation
Sodium sorbate plus heat[3]	0	1,550	2,200	Good flavor
	5	1,000	1,100	Good flavor
	23	.....	.....	Gas formation

[1] Starting material contained 460,000 yeasts and molds and 520,000 bacteria.
[2] 0.06% sodium sorbate added.
[3] 120° F. for 5 minutes.

TABLE 2

Effect of various heat treatments and sodium sorbate on cider stored at 73° F.

Treatment	Days storage	Cells per ml.[1]		Remarks
		Wort	Nutrient	
Sodium sorbate[2]	0	340,000	440,000	Good flavor
	5	155,000	325,000	Good flavor
	8	.....	.....	Gas formation
Sodium sorbate plus 100° F.[3]	0	230,000	250,000	Good flavor
	5	14,000	55,000	Good flavor
	12	.....	.....	Gas formation
Sodium sorbate plus 120° F.[3]	0	1,100	4,000	Good flavor
	5	600	750	Good flavor
	23	.....	.....	Gas formation
Sodium sorbate plus 130° F.[3]	0	0	600	Good flavor
	5	1,050	1,800	Good flavor
	29	.....	.....	Gas formation
Heat to 130° F. only	0	850	3,000	Good
	5	650	1,750	Good
	15	.....	.....	Gas

[1] Starting material contained 690,000 yeasts and molds and 800,000 bacteria.
[2] 0.06% sodium sorbate added.
[3] Heated for 5 minutes.

Table 2 shows the effect of sodium sorbate and various heating temperatures on cider stored at room temperature. As the heating temperature was increased the microbial counts on both the wort and nutrient agar decreased. At a heating temperature of 130° F. for 5 minutes, the storage life of the cider was increased to 29 days when stored at room temperature. This is to be compared with an 8-day storage life of the cider treated with only sodium sorbate, and a 15-day storage life when cider was treated with heat only.

Taste panel evaluation of these samples showed that there were no appreciable differences between the different heat treatments. Tests between the heat treated cider and the original material, which was preserved by freezing, also showed little or no differences.

Citrus fruit salad that was treated with mild heat and sodium sorbate showed no microbial spoilage after 90 days' storage at room temperature. Table 3 shows the results obtained from this experiment. The salad that had no treatment showed profuse gas formation after only 2 days' storage at room temperature. That treated with sodium sorbate alone spoiled in 11 days when stored at room temperature.

In all of the heat treated samples, the top ½ inch of fruit had an oxidized appearance. This reaction is thought to be due to the presence of oxygen in the sealed container. When this oxidized material was

TABLE 3

Effect of mild heat and sodium sorbate on fruit salad stored at 73° F.

Treatment	Days storage	Cells per ml.		Remarks
		Wort	Nutrient	
Control	2	6,200,000	15,000	Gas formation
Sodium sorbate[1]	11	.....	.....	Gas formation
Sodium sorbate[1] plus heat[2]	90	2	5	Good flavor

[1] 0.048% sodium sorbate added to the juice based on net contents.
[2] 120° F. for 5 minutes.

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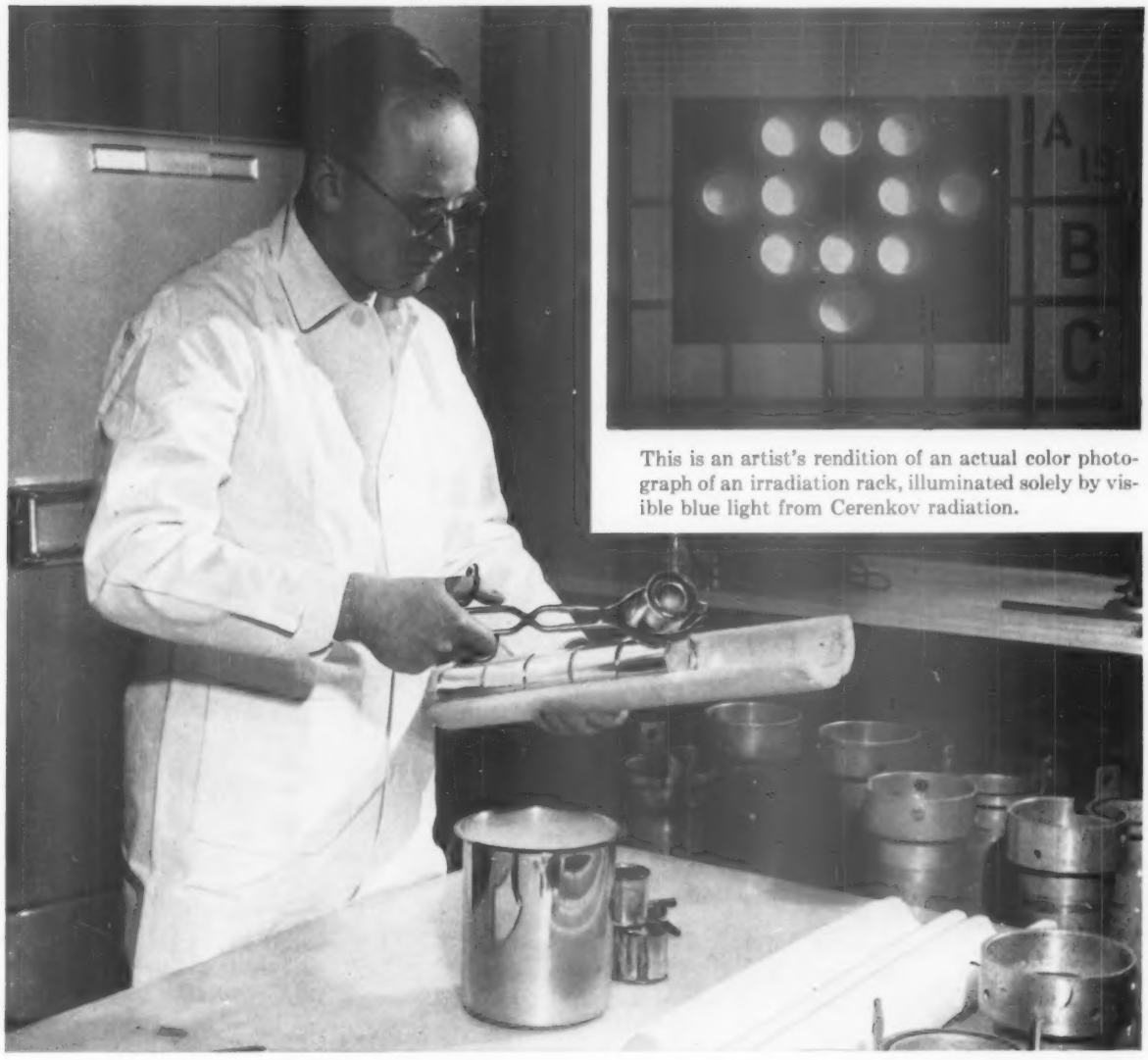
This is an artist's rendition of an actual color photograph of an irradiation rack, illuminated solely by visible blue light from Cerenkov radiation.



One experiment calls for the exposure of frozen canned foods to gamma irradiation. This photo, taken at the Argonne National Laboratory, shows cans being placed in an insulating cylinder. The cylinder will be sealed within one of the aluminum urns (at right), then lowered into the water of the radiation canal. There it is exposed to rays yielding from one to two million roentgens an hour.

High energy irradiation, alone or combined with thermal processing or freezing, shows interesting possibilities as a means for preserving packaged foods. To explore fully this new technique, American Can Company scientists are participating in an extensive irradiation research program.

Part of this work is carried on through cooperative projects at government and university laboratories, part through independent studies at Canco's multi-million-dollar Research Center in Barrington, Ill. As a result of this program, food for the nation's dinner tables some day may be sterilized by nuclear energy.

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removed, the flavor of the remaining salad was satisfactory.

Microbial spoilage was prevented for more than 92 days when fresh peach slices were treated with sodium sorbate and mild heat and stored at room temperature, as shown in Table 4. One treatment spoiled in 21 days due to mold growth on top of the product.

TABLE 4

Effect of mild heat and sodium sorbate on the storage life of peach slices

Treatment	Days to gas formation	
73° F. storage	0.06%[1]	0.12%[1]
Control (no treatment)	3	
100° F. for 15 min.	92	92
110° F. for 10 min.	21[2]	92
120° F. for 5 min.	92	92[3]
50° F. storage		
Control (no treatment)	12	
100° F. for 15 min.	92	92
110° F. for 10 min.	92	92
120° F. for 5 min.	92	92

[1] Sodium sorbate.
[2] All samples showed mold growth.
[3] One sample had mold growth (on top of contents).

All of the samples at both storage temperatures had at least a ½ inch of oxidized fruit at the top. After removing this oxidized portion, the remaining material had good flavor, texture, and color.

SUMMARY

A combination of sodium sorbate (0.06 to 0.12%) and mild heat (120° F. for five minutes) greatly increased the storage life of fresh apple cider, peach slices, and fruit salad. In the presence of 0.06% sodium sorbate, a heat treatment as mild as 100° F. for five minutes destroyed more than 50% of the initial yeasts, molds, and bacteria in cider and increased the storage life to 14 days at room temperature. At 120° F. there was a 99% reduction in microbial counts and the storage life was increased to 23 days at 70° F. Similar results were obtained with peach slices and fruit salad.

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Drained Weight of Canned Apricots

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(Manuscript received September 19, 1958)

Apricots are grown and processed mainly in California. In 1957 the California canning industry packed about 5 million cases—96% of the national pack of apricots. The grade of canned apricots, determined according to the standards of the U. S. Department of Agriculture *(9)*, is based on color, uniformity, defects, and character. Drained weight and cut-out Brix are other factors important in canning because of their relationship to the case yield per ton of fresh fruit.

Various research institutes have published on the drained weight of canned cherries *(1, 2, 3, 10, 12)*, plums *(3)*, berries *(1, 3)*, peaches *(6, 7, 10)*, and pears *(7, 10)*, but not on the factors influencing the drained weight of canned apricots. Apricots of different ripeness levels differ greatly in texture; and overripe fruit breaks down readily after canning. It is not clear if this characteristic could cause variation in the drained weight of the canned product.

This paper presents the results of an investigation on the effect on the drained weight of canned apricot halves of growing area, syrup concentration, ripeness level, fill weight, and storage time.

EXPERIMENTAL MATERIALS AND METHODS

Blenheim apricots. Two tons of Blenheim apricots from the University orchard at Winters were harvested at commercial ripeness level on June 29, 1955, and 2 tons from the Santa Clara area on July 28, 1955. After storage overnight, the fruit was sorted for ripeness by skin color under a standard 500-watt light source equipped with a blue filter. A wide middle band of maturity was selected (Table 1). Twenty apricots were taken at random from each of the sorted samples for physical and chemical analyses. Fruit from the Santa Clara area was divided into 3 ripeness levels before canning (Table 1, samples C, D, E).

TABLE 1

Physical and chemical properties of the Blenheim apricots used in the drained weight study

Sample	Growing area	Ripeness level	Average pressure test (5/16" plunger)	Brix at 20° C.	pH	Total acid as % citric	Brix/acid	Total solids
			(lbs.)					(%)
A	Winters	Medium	1.4	13.9	3.72	1.212	11.5	14.90
B	Santa Clara	Medium	1.4	14.1	3.72	0.928	15.2	15.55
C	Santa Clara	Slightly green	1.9	12.8	3.70	1.143	11.2	14.42
D	Santa Clara	Medium	1.3	15.0	3.80	1.035	14.5	16.67
E	Santa Clara	Ripe	1.0	15.6	3.86	0.911	17.3	17.19

Canning. Two hundred pounds of fresh fruit were used for each variable. The sorted samples were washed, halved, and pitted in a Filice and Perrelli apricot pitter. Unless otherwise stated, 19.5 ± 0.1 oz. of apricot halves and 253 ± 2 ml. of 40° Brix sucrose syrup were added to each No. 2½ can. Segments of apricot halves were added to reach the desired fill weight. In some samples, 253 ± 2 ml. of 30, 50, 60 and 70° Brix sucrose syrup was used instead of the 40° Brix syrup. The cans were sealed in a vacuum closing machine under 15 inches of vacuum, cooked 22 minutes in a continuous rotary cooker at 100° C. (212° F.), and cooled 7 minutes in a rotary water cooler. A total of 72 cans were obtained for each syrup concentration.

Determination of drained weight. The canned apricots were stored in the pilot plant at ambient room temperatures of 20° to 35° C. (68° to 95° F.). Four cans of each sample were taken at random after various storage intervals. The drained weight of each sample was determined after the fruit had drained exactly 2 minutes on a tilted 8-mesh screen (8 in. diameter) as specified in the U. S. Department of Agriculture Standards *(9)*. Average values of the readings were used for plotting curves. The Brix was determined in a Zeiss Opton refractometer after the drained fruit had been mixed 30 seconds in a Waring blender. The Brix of the syrup and of the mixture of fruit and syrup from the blender was also determined.

Pressure test. A Magness-Taylor pressure tester with a 5/16 in. plunger was used.

Total acidity. Ten g. of the sample was titrated in 200 ml. of distilled water with 0.1N NaOH to reach a pH value of 8.0, as indicated by a Beckman pH meter. Results were reported as per cent citric acid.

Total solids. Total solids were determined by drying 10 g. of the sample for 8 hours in an oven at 70° C. under 29 in. of vacuum.

RESULTS

Changes in Brix readings and drained weight during storage. Blenheim apricots from the Santa Clara area were canned as halves at medium ripeness (Table 1, sample B) with a fill weight of 19.5 oz. of fruit (28 to 32 halves) and 10.5 oz. of 40° Brix syrup for each No. 2½ can. The changes in Brix and drained weight of the canned product during storage are shown in Figure 1. One day after canning, the drained weight was only 16.4 oz., or 84.1% of the fill weight. The drained weight increased rapidly for the first 5 to 10 days, and then more slowly as storage time lengthened. At 31 days of storage, drained weight was 17.5 oz. and weight retention was 89%. Storage up to 91 days resulted in an increase in drained weight to 17.7 oz. and in weight retention to 90.8%. Brix readings of the fruit and syrup rapidly approached equality during the first 15 days. The fruit Brix increased and the syrup Brix decreased until they were practically equal at 30 days storage. The equilibrium Brix at 91 days of storage was 23.4° Brix at 20° C.

The same procedures were used for apricots from the Winters area (Table 1, sample A), where the climate is warmer and the apricots usually ripen about 3 to 4 weeks earlier than those from the Santa Clara area. Each No. 2½ can contained 19.5 oz. of fruit (22–28 halves) and 253 ml. of 50° Brix syrup. A similar increase in drained weight with storage was found.

Equilibrium Brix. The relationship of the Brix reading of the cover syrup to the equilibrium Brix of the canned product is shown in Figure 2, representing apricots from the Santa Clara area, canned as halves at a medium ripeness level. As a similar relationship was observed in the apricots from the Winters area, the results are not presented. For the Santa Clara apricots, a cover syrup with a reading of 44° Brix was needed to give an equilibrium Brix of 25°, which is the demarcation point between "heavy" and "extra heavy" syrup *(9)*. Since the Brix readings of the syrup and the fruit differ greatly during the first 2 weeks after canning, it is necessary to mix the syrup and the fruit to determine the equilibrium Brix. Variation in the soluble solids content of the fresh fruit due to ripeness, variety, and climatic conditions, as well as the varying fill-weight of syrup and fruit in the container, may also cause differences in the equilibrium Brix. One may predict the expected equilibrium Brix by using an equation based on a material balance between the soluble solids in the fresh apricot and the cover syrup and those in the canned product as follows:

$$\text{Fresh Fruit weight} \times \frac{\text{Fresh Fruit Brix}}{100} + \text{Cover Syrup weight} \times \frac{\text{Cover-Syrup Brix}}{100} = \text{Weight of canned fruit and syrup} \times \frac{\text{Equilibrium Brix}}{100}.$$

Effect of growing area and syrup concentration. Effect of growing area, syrup concentration, and storage time on drained weight is shown in Table 2. The apricot sample from the Winters area gave a slightly higher drained weight and weight retention than did the sample from the Santa Clara area. The reason is not clear.

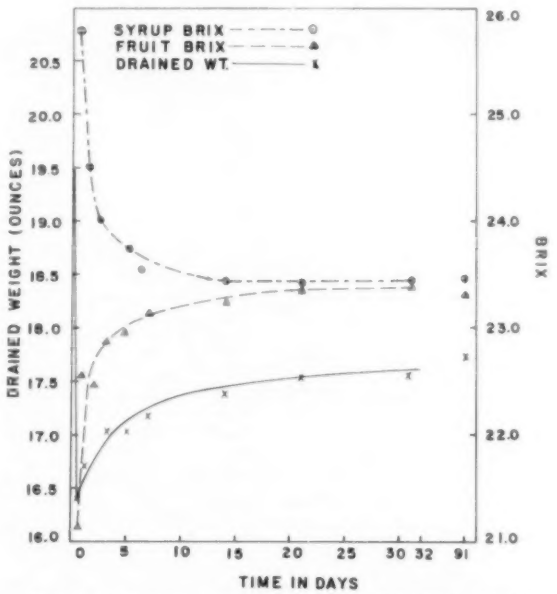

Figure 1. Changes in Brix readings and drained weight of canned Blenheim apricots during storage. (Santa Clara area, medium ripeness, 40° Brix syrup).

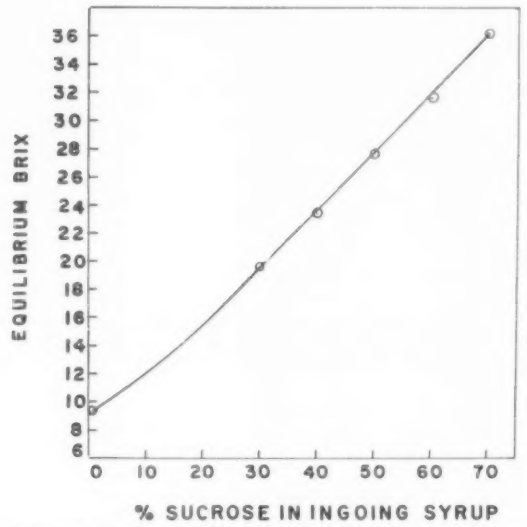

Figure 2. Influence of sucrose concentration in the ingoing syrup on the equilibrium Brix of canned apricots. (Santa Clara, medium ripeness).

Concentration of cover syrup had some effect on drained weight of the canned product when the samples were evaluated shortly after canning. As storage time increased, the difference in drained weight caused by the cover syrup became less pronounced. Comparison of samples stored 120 and 123 days (Table 2) indicated that cover syrup has only a small effect on drained weight.

Effect of fill weight. Fill weight was found to be one of the important factors influencing drained weight. A semi-log plot of storage time versus drained weight, originally developed by Weast *(10)*, is shown in Figure 3. The linear relationship between storage time and drained weight may be used to predict the drained weight of the product at any time after canning if cannery procedures are standardized. Factors such as syrup concentration and fruit ripeness level may cause the slope of the curve to shift slightly. For practical purposes, and if the fruits are at a normal ripeness level, the equilibrium drained weight may be considered as reached 45 to 60 days after canning.

Since the fruits used in this investigation were at the same ripeness level and canned under the same conditions, the slopes of lines A (fill weight 19.0 oz.) and B (fill weight 20.0 oz.) appear almost parallel to each other (Figure 3).

Influence of ripeness level. Differences in the drained weight of apricots canned at different ripeness levels are shown in

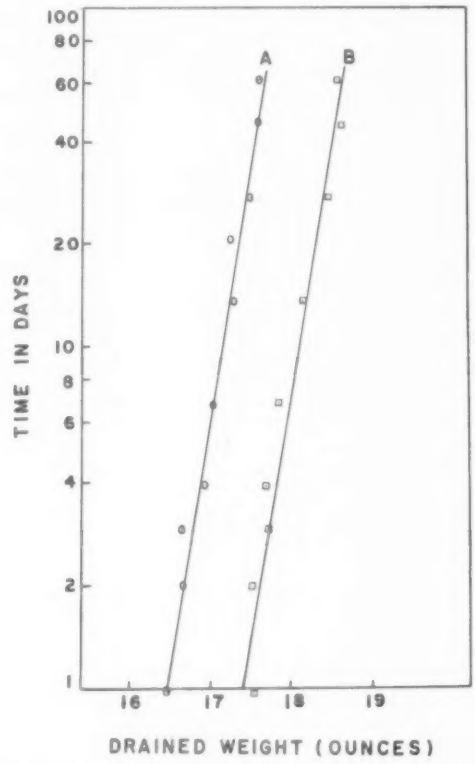

Figure 3. A semi-log plot of time vs. drained weight in Blenheim apricots canned as halves in a 40° Brix syrup. Fill weight of A and B were 19.0 and 20.0 oz. for each No. 2½ can. (Santa Clara, medium ripeness). Least significant differences:

Fill weight = 0.15 oz. at 1% probability level.

Time of sampling = 0.22 oz. at 1% probability level.

TABLE 2

Effect of growing area, syrup concentration and storage time on drained weight of canned Blenheim apricots, 19.5 oz. fill weight, medium ripeness

Winters

Ingoing syrup, ° Brix	Average drained weight at time of sampling (ounces)					Retention, %
	1 day	3 days	9 days	33 days	120 days	120 days
30°	17.42	17.20	17.96	17.99	17.90	91.8
40°	17.97	17.16	17.72	17.91	18.02	92.4
50°	16.63	16.82	17.26	17.61	18.05	92.6
60°	16.40	16.67	17.15	17.55	17.82	91.4
70°	16.34	16.82	17.25	17.40	18.00	92.3

Santa Clara

Ingoing syrup, ° Brix	Average drained weight at time of sampling (ounces)					Retention, %
	1 day	3 days	7 days	31 days	123 days	123 days
30°	16.45	16.62	16.91	17.18	17.33	88.9
40°	16.69	17.02	17.04	17.53	17.96	92.1
50°	15.85	16.48	16.71	17.10	17.61	90.3
60°	15.78	16.29	16.38	17.09	17.45	89.5
70°	15.46	15.98	16.28	17.04	17.41	89.3

Least Significant Differences:
Growing area = 0.11 oz. at 1% probability level.
Sucrose = 0.15 oz. at 1% probability level.
Time = 0.15 oz. at 1% probability level.

TABLE 3

Influence of ripeness level on drained weight of canned apricot halves. 19.5 ounce fill weight, 40° Brix syrup. (Santa Clara area)

Ripeness level	Average pressure test (5/16" plunger)	Average drained weight at time of sampling (ounces)						Retention, %
		1 day	3 days	7 days	21 days	28 days	62 days	62 days
	(lbs.)							
Slightly green	1.9	17.45	17.83	18.02	18.45	18.67	18.93	97.1
Medium	1.3	16.91	17.06	17.54	17.72	17.82	18.18	93.2
Ripe	1.0	16.59	16.76	17.14	17.13	17.60	17.68	90.7

Least Significant Differences:
Maturity = 0.14 oz. at 1% probability level.
Time of sampling = 0.20 oz. at 1% probability level.

TABLE 4

Analyses of variance on the effect of growing area, syrup concentration and storage time on the drained weight of canned Blenheim apricot halves. (Winters and Santa Clara areas)

Factor	Analysis of variance table				
	Sum of squares	Degree of freedom	Mean square	F.	F.99
Growing area	16.70	1	16.70	284.01	11.3
Syrup concentration	11.53	4	2.88	56.47	5.04
Storage time	46.52	4	11.63	229.39	5.04
Interactions					
Growing area x syrup concentration	1.32	4	.330	4.37	3.32
Syrup concentration x time	3.98	16	.249	3.30	2.16
Growing area x syrup	1.31	4	.327	4.33	3.32
Concentration x time					
Error	0.059	16	.00369		
Error (corrected)	11.32	150	.0755		
	11.38	166	.0686		

Least Significant Differences:
Growing area = 0.11 oz. at 1% probability level.
Sucrose = 0.15 oz. at 1% probability level.
Time = 0.15 oz. at 1% probability level.

Table 3. The sample canned at 1.9 lbs. average pressure test (5/16 in. plunger) has an equilibrium drained weight of 18.93 oz. and a weight retention of 97.1%, whereas the sample canned at 1.0 lbs. average pressure test has a value of 17.68 oz. and weight retention of 90.7%. This is important because the firmer fruit (average pressure test of 1.9 lbs.) would meet the required drained weight of 18.0 oz. while the riper sample (average pressure test 1.0 lbs.) would not, even though both are canned under same conditions. If other conditions are equal, the riper fruit produces a canned product of lower equilibrium drained weight and lower weight retention.

Analyses of variance. The analyses of variance of factors influencing the drained weight of canned apricots are shown in Table 4. Growing area, syrup concentration, and storage time were found to be important. The results were significant at a probability level of 1%. The influence of ripeness level on drained weight was also significant at 1% probability level, as shown by the Least Significant Difference values in Table 3.

DISCUSSION

The above results indicate that growing area, storage time, fill weight, and ripeness level are important factors influencing the drained weight of canned apricots. For quality control purposes, fill weight and ripeness level are the more important factors to be considered. In commercial practice it is impossible to fill each can to the same weight since apricot halves differ in size and trade practices do not permit the use of apricot segments to maintain a constant fill weight. The solution is to fill the cans with sufficient fruit to yield a canned product with an average drained weight equal to or slightly above the required minimum. In a No. 2½ can containing 22 to 32 apricot halves, one fruit half may cause a difference in fill weight of over ½ oz. To have a reasonably constant net weight and a fairly uniform head space and vacuum a variable volume of cover syrup has to be added to each individual can.

The United States Standards for grades of canned apricots *(9)* state: "The container shall be filled with apricots as full as practicable without impairment of quality. The product and packing medium occupies not less than 90% of the volume capacity of the container." Thus, the canner may vary the relative amounts of fruit and syrup as long as the required average drained weight can be met. Adjustment of fill weight is necessary to obtain a desired average equilibrium drained weight or a narrow range near the requirement.

The equilibrium drained weight of canned clingstone peaches has been reported to be influenced by sugar concentration in the cover syrup *(6)*. Riper clingstone peaches produced a canned product of slightly higher drained weight than did less ripe fruit. In contrast, the drained weight of canned apricots was distinctly affected by ripeness level of the fresh fruit, and riper apricots gave a lower drained weight than did slightly green fruit. The per cent retention of apricots at equilibrium canned in 40° Brix syrup varied between 90.7 and 97.1% (Table 3), whereas that of canned clingstone peaches reached 101.5% *(6)*. It thus appears that each fruit differs in character, and must be studied individually to have a reliable quality control program.

Drained weight was at a minimum immediately after canning, but increased rapidly the following 5–10 days. Since the concentration of the cover syrup was higher than that of the fruit, the apricot fluid moved into the cover syrup, resulting in a lower

drained weight immediately after canning. The effect of heat during canning on releasing fluid from the fruit into the syrup might also be an important contributing factor. On storage, diffusion of syrup into the apricot tissue caused an increase in weight of the fruit until equilibrium was reached. Changes in density, volume, and weight take place until equilibrium is reached between cover syrup and fruit tissue. The rate and direction of diffusion of the solvent and solute molecules are controlled by the concentration gradient, mobility of the moving molecules, and resistance offered by the apricot tissue.

The reason that ripe apricots gave a lower drained weight than did greener fruit might be explained by the change in pectic constituents existing between the cell walls of the fruit tissue. Hoos, Leonard, and Luh *(4)* reported that, during ripening, propectin in apricots was converted to water-soluble pectin that readily diffused into the syrup. This caused a decrease in firmness of the fruit, facilitating the exchange of constituents between fruit and syrup. In addition, overripe fruit tends to break up during canning. This causes a lower drained weight because a larger part of the fibrous material will go through the screen. Similar views were expressed by Adams and Hirst *(1, 3)* on the drained weight of canned berries. Clingstone peaches do not have a pronounced change of protopectin to water-soluble pectin during ripening, and are much firmer in texture. There is therefore more resistance to an exchange of constituents between fruit and syrup. Thus, 90 days are needed for canned clingstones to reach an equilibrium drained weight, whereas canned apricots need only 45 to 60 days. The two fruits differ sharply in firmness causing a difference in rate and degree of change in drained weight with storage.

The minimum average drained weight needed for apricots halves in heavy syrup for No. 2½ cans is 18.0 oz. *(9)*. The canners must adjust fill weight according to the ripeness of the fresh fruit. Normal practice in the canning industry is to examine representative samples of a product the day after canning. These samples and the data on them are important in quality control. However, an extended period is required for the contents of the container to reach equilibrium. To meet legal requirements and predict equilibrium value, it is important to correlate 24-hour drained weight data with data obtained at equilibrium.

SUMMARY

Various factors that may influence the drained weight and Brix readings of canned, unpeeled, Blenheim apricot halves were investigated. These include growing area, storage time, cover syrup concentration, fill weight, and ripeness level. One day after canning, the drained weight was 84.1% of the fill weight because apricot fluid was lost to the cover syrup. On storage, drained weight increased rapidly for the first 5 to 10 days, and then slowly until an equilibrium drained weight was reached. For practical purposes, equilibrium drained weight may be considered to be reached 45 to 60 days after canning. Cover syrup concentration appeared to affect drained weight during the first few weeks after canning, but had only slight effect on equilibrium drained weight.

Fill weight and ripeness level were important factors influencing drained weight. Apricot halves canned in 40° Brix syrup with a fill weight of 19.5 oz. for each No. 2½ can at average pressure tests of 1.9, 1.3, and 1.0 lbs. gave an equilibrium weight retention of 97.1, 93.2, and 90.7% respectively.

Acknowledgment

The authors wish to thank the Sugar Research Foundation, Inc. for the financial support that made this study possible.

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Time-Temperature Tolerance of Frozen Foods. XVIII.

Effect of Blanching Conditions on Color Stability of Frozen Beans

(Manuscript received August 5, 1958)

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DIETRICH *et al. (2)* measured the initial chlorophyll retention in 19 retail lots of commercially frozen green beans soon after processing and found it to vary from 67 to 95%. The time-temperature conditions of blanching appeared to influence the percentage chlorophyll retained in processing and the latter seemed to be inversely related to the rate of chlorophyll deterioration during storage.

The present investigation was undertaken to study blanching effects and related storage changes in greater detail with laboratory-processed material. Data on green beans processed during two seasons are presented and storage effects are compared with those obtained on some commercial lots.

MATERIALS AND METHODS

Preparation and storage. Blue Lake beans were obtained from the Santa Clara Valley area of central California during the 1955 and 1957 harvest seasons. The 1955 field-run beans were held overnight at 34° F. and processed whole the day after harvest. In 1957, freshly cut 1½ inch, size 4, beans were selected at a processing plant in the morning and transported to the laboratory in insulated shippers precooled to 34° F. The beans were placed in perforated baskets inside the shippers on a layer of crushed ice. Mesh baskets containing crushed ice were placed on top of those containing the beans. No dehydration or discoloration was apparent while some of the beans were held as long as 8 hours.

All beans were brought to a uniform temperature by immersion in 70° to 75° F. tap water for 2 to 3 minutes, just before blanching. The blanching temperatures were 190°, 195°, 200°, and 212° F. and blanching time ranged from 1 to 5.25 minutes. The same insulated steam blancher was used in both seasons. Beans were loaded 1.5 pounds per sq. ft. on wire-mesh trays carried on a slat draper through a 12 in. x 33 in. x 18 ft. steam box. Steam was introduced through pipes spaced 11 inches apart running crosswise above and below the path of the trays with perforations in the pipe facing away from the product. Temperatures below 212° F. were obtained by automatically controlled mixing of air and steam 20 feet before injection into the blanching chamber. Water immersion was used for cooling in 1955 and heavy sprays of water in 1957.

Samples were water blanched in 1955 in rectangular perforated baskets submerged and agitated in water heated by steam injection through perforated tubing. Temperature was controlled by hand operation of the steam valve during blanching. In 1957, water blanching was carried out by placing 3.8 or 8.5 pounds of beans in a perforated basket, 11 inches in diameter by 11 inches high, with lid, and submerging in about 90 gallons of water. To heat the water, steam was passed through 30 feet of half-inch tubing mounted in the bath and temperature was controlled by an automatic regulator. Uniform transfer of heat to the product was assured by use of a circulating pump and movement of the basket up and down. Cooling was done by transferring the baskets of beans to 30-gallon tanks of circulating tap water for 2 minutes. All beans were frozen on 2 x 3 ft. wire-mesh trays in moving air at −20 to −30° F. Beans were removed from the trays when frozen, or the following morning, and placed in 10- or 30-pound tins at −20° F. Analyses on this material were run within a month after processing.

A portion of each lot was held at −20° F., where no measurable change occurred, for subsequent comparison with stored samples. The remainder was divided into 200 to 500-g. amounts, packaged in polyethylene bags, and stored at 20° F. for 2-, 4-, and 6-week periods in a room such as described by Lowe *et al. (5)*.

In addition, data obtained in the investigation of TTT (time-temperature tolerance) lots *(2)* are used where pertinent to this report.

Peroxidase. Determinations were made by the semiquantitative and quantitative methods of Masure and Campbell *(6)*. Results of the quantitative method are expressed as increase in color density, D/M units, for 2 ml. of 1 + 3 enzyme extract.

The recent test paper procedure of Morris *(7, 8)* was also used, in which small amounts of vegetable or vegetable extract could be quickly tested for peroxidase activity. The time in seconds for the appearance of blue color was compared with results from the Masure-Campbell procedures to interpret degree of blanching.

Chlorophyll and pheophytin. The method used to determine the conversion of chlorophyll to pheophytin is described by Dietrich *(1)*.

Ascorbic acid. The indophenol colorimetric method as discussed by Dietrich *et al. (3, 4)* was used to determine reduced ascorbic acid in filtered 0.5% oxalic acid extracts of 1 part beans blended with 5 parts acid.

Organoleptic evaluations. The 1955 pack of whole beans was trimmed and cut to one-inch lengths before subjective appraisals. Samples were ranked for flavor and color as described by Dietrich *et al (2)*. Color of uncooked samples was judged before complete thawing in the comparison of −20° F. control material representing different blanching conditions. When effects of storage conditions were to be ascertained, samples stored at 20° F. and appropriate controls were judged after thawing. These samples were cooked 7 minutes after resumption of boiling, judged for flavor and for degree of sloughing, and again judged for color. Some samples of the 1957 lot were selected and ranked for difference in tenderness to determine effects of blanching temperatures.

RESULTS AND DISCUSSION

Processing conditions for 1955 and 1957 laboratory lots are given in Table 1, along with resultant data on enzyme inactivation, chlorophyll loss, and ascorbic acid content.

Chlorophyll conversion during processing. Green beans just adequately blanched to peroxidase inactiva-

* A laboratory of the Western Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture. Presented at IFT meeting, Chicago, Illinois, May 1958.

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TABLE 1

Effect of blanching conditions on peroxidase, chlorophyll, and ascorbic acid

Blanching conditions			Peroxidase activity					Chlorophyll loss		Ascorbic acid	
			Quant.[1]		Semi-quant.[2]		Paper[3]				
°F.	Medium	Time	1955	1957	1955	1957	1957	1955	1957	1955	1957
		(min.)	*(D/M units)*	*(D/M units)*	*(min.)*	*(min.)*	*(sec.)*	*(%)*	*(%)*	*(mg./100 g.)*	*(mg./100 g.)*
190	water	1		47		<1(+)	33		4.2		4.8
		3		4		6(−)	107		11.9[4]		4.8
		4		0					16.6		3.3
		5	17		8(−)			22.7[4]	18.7	15.3	3.2
195	water	5¼	0		(−)			24.5		15.5	
200	water	1		15		2(+)	91		4.0		5.2
		2		4		12(−)	180		8.5[4]		4.8
		3		0					13.0		4.8
		5							21.3		5.0
212	water	1	4	9	(−)	6(−)	120	5.4[4]	5.6[4]	19.0	4.7
		2	0	0		(−)	>240	11.5	10.5	15.2	4.2
		3						15.6	15.4	15.5	4.2
		5							24.5		4.3
190	steam	1		167		<1(+)	22		0.9		3.4
		3		5		3.5(+)	75		11.7		4.8
		4		4		10(−)	130		15.9[4]		3.8
		5	4	0	(−)			24.8[4]	25.4	13.9	4.0
195	steam	5¼	0		(−)			28.6		14.2	
200	steam	1		12		5(−)	105		4.3[4]		5.4
		2		5		10(−)	>120		9.6		4.8
		3		0					16.3		5.2
		5							26.0		4.6
212	steam	1	2.3	0	(−)	10(−)	>180	7.2[4]	5.9[4]	17.4	5.9
		2	0					12.2	12.7	15.3	5.6
		3	0					18.6	21.7	13.6	5.5
		5							37.4		5.5

[1] Divisions per minute increase in color as measured on a Klett-Summerson colorimeter.
[2] Test shows inadequate blanch (+) when color appears within 3.5 minutes; a longer time indicates adequate blanch (−) or overblanch.
[3] Morris test paper interpreted to show adequate blanch when color does not appear in 100 seconds.
[4] Shortest blanch time in the series for adequate blanch.

tion, or a little longer, had a clearer green color when blanched at higher temperatures (200° to 212° F.) and shorter time (1 to 2 minutes) than when blanched at lower temperatures (190° to 195° F.) and longer times (3 to 5 minutes). Overblanching, 2 to 3 times adequate, at any temperature was undesirable because of poor color as a result of more conversion of chlorophyll to pheophytin.

Comparison of 1955 and 1957 data (Table 1) showed similar changes in chlorophyll for the same blanching conditions. When time or temperature was increased, the percentage conversion increased. Steam blanching caused more conversion than water blanching in most instances where time and temperature were similar. Quantitative peroxidase data indicated that the steam blanched product had absorbed more heat.

A graph of the 1957 data would show the percentage chlorophyll loss to follow a linear relationship with blanching time at a given temperature. Although the raw beans had little, if any, converted chlorophyll, most of the lines of a graph would not pass through the origin. This could be due to a delay in the chlorophyll dissociation reaction until the beans had reached an intermediate temperature. Chlorophyll was considerably faster at 212° F. than at 190° or 200° F. The rates varied from 4 to 8% conversion per minute based on the change which occurred from 1 through 5 minutes.

Ascorbic acid retention during processing. Variation in ascorbic acid content between lots (Table 1) was greater than variations caused by different processing conditions within a lot. Again, as for chlorophyll, a short-time, high-temperature blanch gave better retention. The 1955 lot with higher initial ascorbic acid content had more mature beans (size 6 in contrast to size 4). Limited tests on other material have shown seeds to contain 2 to 3 times as much ascorbic acid as the pod material. Therefore, the 1955 lot with the more mature beans could be expected to have a higher ascorbic acid content.

Chlorophyll retention during storage. Effects of blanching conditions influence the rate of chlorophyll deterioration during storage as well as during processing. Analytical results on retention are given in Table 2 along with calculated deterioration rates. Chlorophyll retention (100 − % conversion) was used to calculate the rates of deterioration, since in previous studies *(2)* and in the present one, when logarithmic values of percentage chlorophyll were plotted against storage time, most of the data closely fitted a straight line. This indicated that chlorophyll was changed to pheophytin at a rate always equal to a fixed percentage of the intact chlorophyll, i.e., the change was the same type as that defined by the Compound Interest Law.

Some variations were noted from the straight line log relationship. Rates of deterioration at 20° F. were 10 to 70% faster in two-thirds of the samples during the first 2 weeks when compared to rates based on the 2-to-6-week period. These variations occurred in slightly underblanched and just adequately blanched material. A similar change in rate was noted in the commercial lots *(2)* when stored in the temperature range 15° to 30° F. but was not apparent in the 0° to 10° F. range. The reason for change in rate with storage time was not apparent.

As found in processing, high-temperature, short-time blanching conditions resulted in more chlorophyll retention during storage than low-temperature, long-time blanching conditions. Differences in reten-

tion are illustrated by samples just adequately blanched and stored 4 weeks at 20° F.; thus samples water blanched for 1 minute at 212° F. retained 78.4%; for 2 minutes at 200° F. retained 73.6%; and for 3 minutes at 190° F. retained 65.6% intact chlorophyll. Underblanched and overblanched samples retained less chlorophyll under identical storage conditions than just adequately blanched samples. Similar underblanching effects have been noted previously by Dietrich *et al. (4)* in frozen peas.

Comparison of chlorophyll deterioration rates (S in Table 2) based on a regression line for the 0-to-6-week period showed that underblanched materials deteriorated most rapidly and that samples overblanched in water showed little or no increase in deterioration rate with a decrease in Ci. On the other hand, samples overblanched in steam did show a moderate increase in rate in this respect.

An important trend in chlorophyll retention in storage is the decrease in rate, S, as the blanching temperature is increased (blanching time constant). Although the initial chlorophyll may also decrease with increased blanching temperature, the decrease in deterioration rate is sufficient to offset this initial difference in extended storage.

Deterioration rates for the blanching series varied more with respect to initial chlorophyll, Ci, than the rates for the TTT lots 1 to 6. However, data for the commercial lots (Table 3) indicated similar trends for change in chlorophyll deterioration rates with respect to blanching medium and blanching temperature as were found for the laboratory lots. Application of equations developed by Dietrich *et al. (2)* for estimating storage life from Ci values should be limited to material just adequately or moderately but not severely over-blanched. Since most commercial lots will fall in this degree of blanch, the equations remain useful as an industry tool for predicting storage life at different temperatures.

Effect of blanching conditions on texture, visual color, and flavor. The 1955 studies indicated that blanching at 212° F. produced better color and softer texture than blanching at 190° and 195° F. The latter conditions gave a tough, "squeaky" texture and duller color. Overblanching at 212° F. caused extensive softening and a less desirable color as more chlorophyll was converted to pheophytin. Sloughing was sometimes excessive, after cooking, in beans overblanched above 200° F., but those just adequately blanched at 212° F. were satisfactory.

The 1957 samples were grouped for texture appraisal on the basis of blanching temperature and degree of enzyme inactivation. Ranking data are given in Table 4. Higher blanching temperatures in

TABLE 2

Chlorophyll retention and deterioration rate at 20° F., laboratory lots

Blanch temp., °F.	Storage time at 20° F. weeks	Percentage retention, Ci and deterioration rate, 1957 season: Blanching time, minutes, for water (W) and steam (S)									
		1		2		3		4		5	
		W	S	W	S	W	S	W	S	W	S
190	0	95.8	99.1			88.1[1]	88.3	83.4	84.1[1]	81.3	75.0
	2	79.8	75.2			74.4	73.2	72.6	70.8	71.0	62.1
	4	65.8	56.4			65.6	63.6	62.9	60.5	62.6	51.8
	6	55.4	47.1			57.8	54.8	54.2	52.4	55.0	43.6
Rate[2]		5.7	7.8			4.3	4.9	4.5	4.9	4.0	5.6
200	0	96.0	95.7[1]	91.5[1]	90.4	87.0	83.7			78.7	74.0
	2	82.5	81.8	81.7	78.2	76.7	71.5			70.3	62.2
	4	74.4	72.4	73.6	68.0	68.8	62.2			63.1	53.8
	6	68.8	64.6	66.1	60.0	62.4	53.0			55.2	.....
Rate		3.4	4.0	3.4	4.2	3.4	4.7			3.6	4.9
212	0	94.4[1]	94.1[1]	89.5	87.3	84.6	78.3			75.5	62.6
	2	85.1	82.2	80.4	75.7	75.6	67.4			.....	.....
	4	78.4	74.2	73.6	67.0	66.5	59.8			61.8	44.8
	6	72.8	66.3	66.6	59.3	63.1	51.0			.....	.....
Rate		2.7	3.6	3.0	4.0	3.1	4.4			(4.2)	(5.3)

		Percentage retention, 1955 season									
								5 min. at 190°		5¼ min. at 195°	
212	0	94.6[1]	92.8[1]	88.5	87.8	84.4	81.4	77.3[1]	75.2[1]	75.5	71.4
	4	76.3	76.3	74.8	70.7	69.5	63.4	53.7	56.4	59.8	53.8

[1] Initial chlorophyll, Ci, for samples just adequately blanched to peroxidase inactivation.
[2] Rate is expressed as 1000 x slope (S) of the line for regression of chlorophyll as log % retention on days.

TABLE 3

Chlorophyll retention and deterioration rate at 20° F. for commercial retail packs

	TTT lot No.					
	4	2	5	1	3	6
Chlorophyll, Ci, %	95.2	93.1	85.9	81.2	80.0	73.8
Rate[1]	2.4	1.8	3.2	3.7	4.1	5.9
Blanch, °F., W or S[2]	212°, W	212°, W	205°, W	212°, S	212°, S	190°, S
Blanch time, min.	1	1 to 2	2	2¼	2¼	5

[1] For rate units see footnote 2, Table 2.
[2] W = water; S = steam.

TABLE 4

Effect of blanching temperature on texture

Storage °F.	Blanch medium				
		Blanch temp., °F.	212	200	190
		Blanch time, min.[1]	1	2	4
		Cook time, min.	7	7	7
−20°	Water	Average ranks[2]	1.4	1.8	2.9
6 wk. at 20°	Water	Average ranks[2]	1.8	1.4	2.9
−20°	Steam	Average ranks[2]	1.0	2.0	3.0
6 wk. at 20°	Steam	Average ranks[2]	....	1.0	2.0
		Cook time, min.	7	8	8
−20°	Water	Average ranks	1.5	1.8	2.7
−20°	Steam	Average ranks	1.2	1.8	3.0

[1] Blanch time was approximately minimum adequate for enzyme inactivation at each temperature.

[2] Rank 1 = softest, 3 = firmnest; average of 2 replications with 8 judges except bottom line, which was single.

both water and steam produced a more tender texture. Increasing the cooking time in boiling water for the 190°- and 200° F.-blanched samples by an amount equal to the blanching time at 212° F. did not significantly change the relative texture ranks of the 3 samples. Also, storage for 6 weeks at 20° F. did not change the order of texture ranks.

Effect of degree of blanching on texture was noted in Lot 9 of TTT beans where some packages contained excessively tough beans. Samples with tender texture had low peroxidase activity by Morris' test paper procedure *(7, 8)*, whereas those with tough texture had the highest peroxidase activity and were considered to be inadequately blanched. This was true for samples stored at −20° F. and 0° F. for 0, 4, 8, and 12 months. Off-flavor development at 0° F. was independent of variation in texture. Visual color observations on samples just adequately blanched, before and after storage, showed that samples blanched at higher temperatures (200° to 212° F.) had a clearer green color than those blanched at lower temperatures (190° to 195° F.). Judges' comments on flavor indicated a similar preference for high-temperature, short-time-blanched material. Thus the same blanching conditions gave the best color, texture, and flavor retention in green beans both during processing and storage.

This is in accord with the extensive data on chlorophyll conversion and subjective appraisal developed in the TTT study *(2)*.

SUMMARY

Chlorophyll loss during blanching was found to be linear with respect to time at a given temperature. Blanching temperature and degree of blanch affected chlorophyll retention in storage, which was related to initial chlorophyll, as previously shown *(2)*, within certain limits of enzyme inactivation. Color and texture were also affected by blanching conditions. The key to better quality in frozen green beans was found to be short-time adequate blanching in the temperature range 200° to 212° F.

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Use of Extreme Value Control Charts in the Packaging Industry*

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(Manuscript received May 31, 1958)

STANDARD TYPES of control charts for averages and ranges are widely used in many manufacturing operations to assure consistent product quality. However, in food packaging operations it is frequently more desirable to control actual maximum and minimum fills rather than the average fill or the range of fills: for example, regulation of filling equipment to prevent over- and underfills, or setting upper and lower rejection limits for an automatic weighing device. Although the Federal Food, Drug, and Cosmetic Act *(1)* requires an accurate label declaration of the net weight of a packaged product, it does not give specific minimum tolerances for weight, count, or measure. However, a "reasonable" deviation from the declared contents is acceptable *(1)*. The interpretation of a "reasonable" deviation by regulatory officials depends, to a large extent, upon each individual packer's process. Thus adequate control of high-speed, continuous, food packaging operations has legal significance as well as economic import.

Natural variations in food packaging operations account for a portion of both negative and positive deviations from the declared "net weight" of the product. Statistical quality control charts reveal the patterns of natural process variation *(5)* and objectively determine if the deviations from the declared contents are "reasonable" for an individual packer. In appraising the filling operations, it is more desirable to apply control chart techniques directly to underfills and overfills rather than to averages and ranges. Specific evaluation of the extent of underfilling and overfilling in a packing process is accomplished by the use of extreme value control charts.

This paper describes the calculation of the chart limits and discusses some of the uses of extreme value control charts. The example used to demonstrate this method was taken from the food industry.

COMMERCIAL OPERATION EXAMPLE

The food product was filled into metal containers by automatic, multihead filling machines. The declared net weight on the label was 8 ounces or 226.8 g. A process capability study was run on the filling operation under normal operating conditions to determine the minimum point of underfilling and the maximum point of overfilling. Six successive samples of filled containers were drawn once an hour from the production stream from each filling-head until 25 groups per head were accumulated. Net weight of the contents of each container was determined by standard procedures: each filled container was weighed, emptied, and again weighed. Net weight of the product in each container was then determined by subtraction. All data were recorded in grams. A sample of the data accumulated from filling-head No. 1 is shown in Table 1. This filling-head was representative of the filling machine average and all control chart calculations are confined to this particular filling-head.

TABLE 1

Sample of data from filling-head No. 1 (6 cans per sub-group; net weight in grams)

Sub-group number	Maximum value	Minimum value	Midrange $\frac{(\max + \min)}{2}$	Average	Range
1	229.5	225.5	227.5	227.8	4.0
2	229.5	221.0	225.3	225.8	8.5
3	232.5	224.0	228.3	228.4	8.5
4	233.0	225.5	229.3	228.3	7.5
5	231.0	225.0	228.0	227.3	6.0
....	.....	.....	.....	.....	....
21	237.0	227.5	232.3	231.5	9.5
22	235.5	228.5	232.0	233.3	7.0
23	234.0	227.0	230.0	231.5	7.0
24	231.5	225.5	228.5	228.8	6.0
25	232.0	225.0	228.5	228.3	7.0
Average	232.8	225.5	229.2	229.3	7.3
Symbol	$\bar{X}_{max}$	$\bar{X}_{min}$	$\bar{C}$	$\bar{\bar{X}}$	$\bar{R}$

AVERAGE AND RANGE CHARTS

Figure 1 shows the pattern of filling variation obtained when the conventional average charts were plotted for these data.

The range chart (Figure 1) shows that the variation in filling weight from can-to-can is almost too consistent since all of the 25 ranges lie within the two sigma and three sigma limits. Furthermore, this chart does not show the value of the smallest fill or the value of the largest fill that will be obtained from this filling-head. The conventional average chart (Figure 1) shows that the average quality level of the product from filling-head No. 1 varied extensively over the sampling period, with 9 groups lying outside of the two sigma limits and two outside the three sigma limits. This filling-head operated at a nominal filling weight of 229 g.; 2 grams over the declared content. Again the chart does not show the lower limit of underfill nor the upper limit of overfill for single containers from this filling-head.

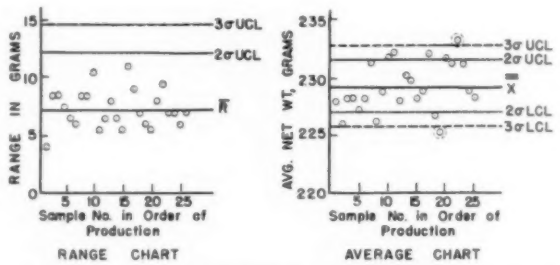

Figure 1. Conventional average and range control charts for filling-head No. 1 (6 containers per sub-group).

*Presented at the Eighteenth Annual Meeting of the Institute of Food Technologists, Chicago, Illinois, May 28, 1958.

Calculations

The limits of these charts are based on well-known control chart factors *(2)*. The three sigma limits for the Range Chart for samples of 6 containers are:

$$D_3\bar{R} = 0 \times 7.3 \text{ g.} = 0 = \text{Lower Control Limit} \quad (1)$$

where: D_3 = a factor dependent upon sample size;

$\bar{R}$ = the average range

$$D_4\bar{R} = 2.004 \times 7.3 \text{ g.} = 14.6 \text{ g.} = \text{Upper Control Limit} \quad (2)$$

where: D_4 = a factor dependent upon sample size

The three sigma limits for the Average Chart for averages of 6 containers are:

$$\bar{\bar{X}} \pm A_2\bar{R} = 229.3 \pm 0.483\ (7.3 \text{ g.}) = 229.3 \pm 3.5 \text{ g.} \quad (3)$$

where: $\bar{\bar{X}}$ = grand average

A_2 = a factor dependent upon sample size

Lower Control Limit = 225.8 g. Upper Control Limit = 232.8 g.

EXTREME VALUE CHARTS

Figure 2 shows the data from filling-head No. 1 plotted as extreme value control charts. The chart on the left showing underfills is obtained by plotting the lowest sample value from each sub-group. The chart on the right showing overfills is obtained by plotting the highest sample value from each group. The midrange chart in the center provides information about the process average since the sample midrange, $\frac{(\text{Max} + \text{Min})}{2}$, is an estimate of the central point of the sample. The chart for underfills shows normal variation in the filling operation with one group outside of the two sigma limit but none outside of the three sigma limit. The limit of underfills under normal operating conditions for this filling-head is 220.0 g.; the average underfill is 225.5 g. The chart for overfills also shows normal variation in the filling operation over this sampling period with two groups outside the two sigma limit but none outside the three sigma limit. The limit of overfills for this filling-head, under normal operating conditions, is 238 g. and the average overfill, 232.8 g. The midrange chart shows 5 groups outside the two sigma limit but none outside the three sigma limit. The estimate of the process average obtained from the midrange chart is 229.0 g.

These extreme value control charts (Figure 2) accomplish their major objective: specification of tolerances for overfills and underfills under normal operating conditions for filling-head No. 1. Any fill below 220 g. is an underfilled container and any fill above 238 g. is an overfilled container when a sample of 6 containers is taken from this specific head. These tolerances indicate that the fill of a single container is expected to deviate 7 g. below and 11 g. above the declared label weight. An additional advantage to this method of control charting is that a very simple estimate of the sample average, the midrange, is used to obtain the average quality level of the filling process. These extreme value and midrange charts resulting from the process capability study are prototypes of standards of conformance used for directly controlling underfills and overfills during the commercial packaging operation.

Calculations

The three sigma limits of the Extreme Value and Midrange Charts *(6)* are based on G_2 and H_2 factors reported by Cowden *(3)*. The three sigma limits for the Underfill and Overfill *(3, 6)* charts are:

$$\bar{c} \pm H_2\bar{R} = 229.8 \pm 1.27\ (7.3 \text{ g.}) = 229.2 \pm 9.3 \text{ g.} \quad (4)$$

where: $\bar{c}$ = average midrange

H_2 = a factor dependent upon sample size

The Lower Control Limit for underfills is 219.9 g. The center line for this chart is the average minimum sample value: $\bar{X}_{Min} = 225.5$ g.

The Upper Control Limit for overfills is 238.4 g. The center line for this chart is the average maximum sample value: $\bar{X}_{Max} = 232.8$ g.

The three sigma limits for the Midrange Chart are:

$$\bar{c} \pm G_2\bar{R} = 229.2 \pm 0.57\ (7.3 \text{ g.}) = 229.2 \pm 4.2 \text{ g.} \quad (5)$$

where: G_2 = a factor dependent upon sample size

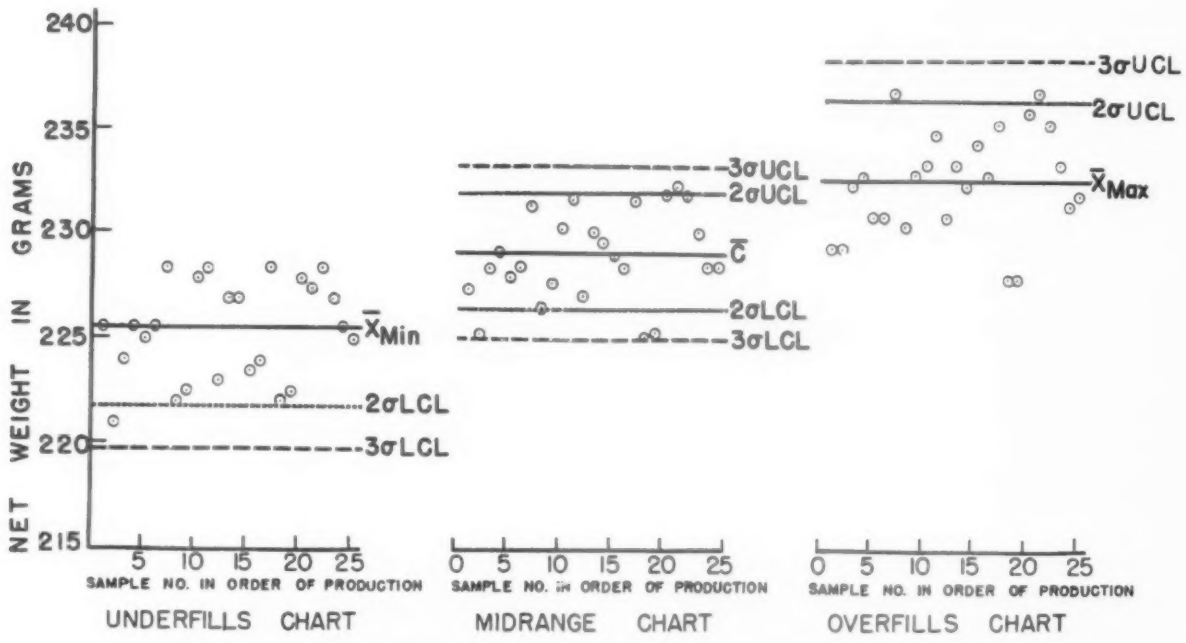

Figure 2. Extreme value control charts for filling-head No. 1 (6 containers per sub-group).

Lower Control Limit = 225.0 g. Upper Control Limit = 233.4 g.

The factors, G_2 and H_2, are obtained from Table 2.

TABLE 2

Factors for midrange and extreme value charts using range

n = Number of items per group	G_2[1] (Midrange)	H_2[2] (Extremes)
2	1.88	2.72
3	1.07	1.82
4	0.80	1.53
5	0.66	1.36
6	0.57	1.27
7	0.52	1.20
8	0.47	1.15
9	0.44	1.10
10	0.42	1.07

[1] G_2 factors quoted from Cowden (3), Table 22.2, by permission of publisher.

[2] H_2 factors quoted from Cowden (3), Table 22.5, by permission of publisher.

Only one limit for each extreme value was calculated for the data from filling-head No. 1. When only the lower and upper limits for underfill and overfill are used, samples in which the lowest single value lies below the lower limit for underfilling, and the highest single value lies above the upper limit for overfilling give indisputable evidence that the process level has shifted.

Two limits may be applied to each chart about the underfill or overfill center line if double controls are desired. If these additional limits are plotted, satisfactory evidence is obtained of a shift in process level under the following conditions:

(1) The lowest single value lies above the limit of underfill and the largest single value lies above the limit of overfill.

(2) The lowest single value lies below the limit of underfill and the largest single value lies below the limit of overfill.

COMPARISON OF OPERATING CHARACTERISTIC CURVES

In Figures 3 and 4, the operating characteristic curves of the conventional average and range charts are compared with those of the midrange and extreme value charts for samples of six drawn from a normal population. The operating characteristic curve for the average chart (Figure 3) indicates that if the population average is 229.3 g., the chart will accept samples with an average below 224.0 g. and above 234.6 g. 10% of the time. However, the midrange chart—with midranges equal to these same values—will accept samples approximately 22% of the time. The control chart for averages is therefore slightly more sensitive than the midrange chart for detecting shifts in the average quality level of a normal population.

The operating characteristic curves for the range chart and for the extreme value charts are shown in Figure 4. Again assuming normality, if the ratio of the sample variation to population variation is as high as 2.6, the extreme value charts will accept samples only 10% of the time whereas the range chart will accept samples 25% of the time. This comparison demonstrates that extreme value charts are more sensitive to shifts in maximum and minimum sample values than the range chart. The reason for this greater sensitivity is that the range is based on an absolute difference, regardless of the numerical values involved, whereas the individual extremes of the sample retain their separate, numerical identities.

The sampling frequency for extreme value and midrange charts depends upon how rapidly the process changes. A relatively stable process is sampled less frequently than a rapidly changing process. The exact sampling frequency is determined by studying a specific process.

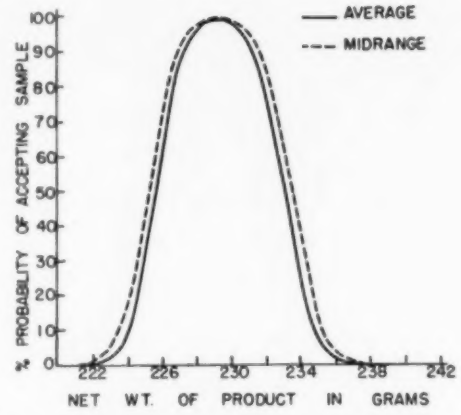

Figure 3. Operating characteristic curves for average and midrange control charts (normal population) n = 6.

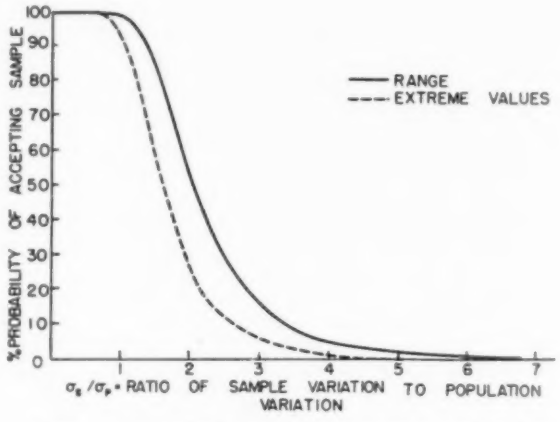

Figure 4. Operating characteristic curves for range and extreme value control charts (normal population) n = 6.

Extreme Value Control Charts in Process Control

Extreme value control charts serve 3 purposes in process control:

(1) they provide rational tolerances for underfills and overfills;

(2) these charts set a standard of conformance for the direct control of under-and overfills, and of the process average, in commercial operations; and

(3) extreme value control charts aid in establishing realistic rejection limits for sample or automatic checkweighing so that these limits are directly related to filling or packaging capacity.

STANDARD OF CONFORMANCE

A standard of conformance for commercial process control is the result of a satisfactory process capability study. The standard of conformance for underfills, overfills, and the average process level for filling-head No. 1 resulted from the data obtained from this head. In actual practice, it is necessary to determine whether or not the individual filling-heads of a multistation machine are operating at different process

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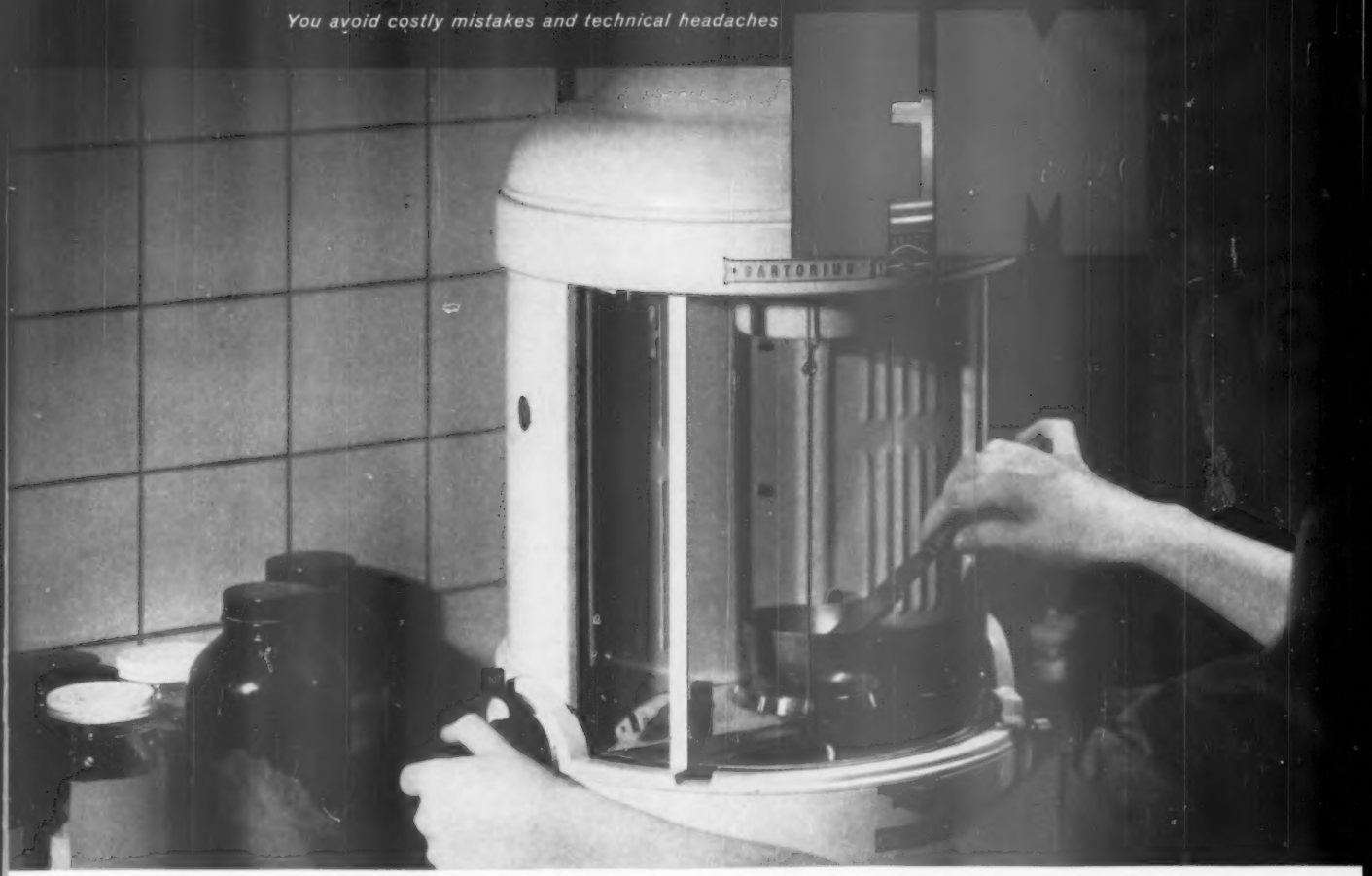

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INSIDE SCIENCE

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The Vital Story of VITAMIN A

by Science Writer

THE "FIRST" VITAMIN

Vitamin A was probably the first to be discovered. As early as 1909 Hopkins and Stepp found that certain fat-soluble substances were necessary for the growth of mice and rats. Between 1913 and 1915, working independently, the teams of McCollum and Davis, and Osborne and Mendel revealed the existence of a fat-soluble fraction in butter, egg yolk and cod-liver oil, which was essential for the growth of laboratory animals. McCollum and Davis concluded that the unknown substance was organic in nature. They had, in effect, discovered vitamin A, even though they did not so name it.

An interesting point: McCollum and Davis noted that the word "vitamine," coined by Casimir Funk a year or so previously, might be used to describe the growth factor they had found. Subsequently, McCollum (and Kennedy) reversed this opinion and suggested that the unknown substances which induced growth be called *fat-soluble A* and *water-soluble B*. In their opinion these phrases better described the unknown factor. Casimir Funk disagreed, however, pointing out that, to be truly descriptive, the phrases should read *growth-promoting fat-soluble A*, etc. This obviously being cumbersome, Funk suggested the designations: vitamine A, vitamine B, and so on. These (with the final "e" omitted) are now firmly embedded in the language.

Other investigators worked on the problem of carotene, beginning in 1831 when Wackenroder isolated that substance from carrots. We shall see later how vitamin A and the carotenes, particularly beta carotene, are interrelated.

TRACKED DOWN

Various tries at isolating vitamin A were made in the 1920s. Investigators in Japan and England attempted without success to extract the elusive vitamin from cod-liver oil.

After establishing the structural formula of beta carotene, Paul Karrer of Switzerland turned his attention to vitamin A. He and his colleagues, using halibut-liver oil (which has a much higher potency than cod-liver oil) succeeded in determining the structure of the vitamin A molecule in 1931.

WHAT IT IS

Pure vitamin A crystals are pale yellow in color. They are soluble in fat and in fat solvents but not in water. The chemist's formula is $C_{20}H_{30}O$, expressing the vitamin's composition of carbon, hydrogen, and oxygen. Beta carotene has the formula $C_{40}H_{56}$.

Vitamin A is stable to light and heat, but is destroyed by oxidation and ultraviolet light.

Two vitamins A have been discovered. Vitamin A_1 occurs in animal products such as egg yolk, liver, butter, and in the livers of salt water fish. Vitamin A_2 is found in fresh-water fish livers. As now used by pharmaceutical and food manufacturers, vitamin A is in liquid form — in solution in edible, vegetable oil — or in dry granular form in which tiny droplets of the liquid vitamin are encased in a dry, edible material.

ACTION

Human beings receive their vitamin A from many sources. They eat vegetable foods rich in beta carotene (a provitamin A) which is then converted by the body into a vitamin. They eat animal products which contain the vitamin. They eat processed foods which are fortified with beta carotene or vitamin A or both. They use pharmaceutical preparations of the vitamin, with or without other vitamins, for therapeutic or protective effect.

The liver has been found to be the main storage site of vitamin A. It is also lodged in the kidneys, lungs, adrenal glands, and body fat.

It is believed that provitamins A are converted to the vitamin in the intestinal wall, the liver, and other parts of the body through the action of the enzyme called carotenase.

Vitamin A is absorbed primarily in the healthy intestine and is carried in the lymph and blood to the body's storage depots.

HOW MUCH DO WE NEED?

According to the Food and Nutrition Board of the National Academy of Science — National Research Council, in its 1958 publication #589, vitamin A is needed daily (in various amounts depending on age and sex) to maintain good nutrition of healthy persons in the U. S. A. The following table expresses the Board's recommendations in International Units of the vitamin.

NATIONAL RESEARCH COUNCIL RECOMMENDATIONS FOR DAILY VITAMIN A INTAKE

Men (all ages)	5,000	Children (1–3 years)	2,000
Women (all ages)	5,000	Children (4–6 years)	2,500
Women (pregnant, second half)	6,000	Children (7–9 years)	3,500
Women (lactating)	8,000	Children (10–12 years)	4,500
Infants (2–6 months)	1,500	Boys (13–19 years)	5,000
Infants (7–12 months)	1,500	Girls (13–19 years)	5,000

The Food & Drug Administration of the U. S. Department of Health, Education and Welfare has set the following standards as being the *minimum* daily requirement. In other words, these amounts are the *least* which can be ingested to prevent recognizable signs of deficiency disease from developing. There is an opinion among nutrition experts that the *minimum* amount of a vitamin is not necessarily the best criterion.

F. & D. A. *MINIMUM* DAILY REQUIREMENTS OF VITAMIN A

(Measurements in U. S. Pharmacopeia (U.S.P.) units which equal International Units)

Men and Women	4,000	Children (1–11 years)	3,000
Adolescents (12–19 years)	4,000	Infants (to 1 year)	1,500

DEFICIENCIES AND MEDICAL USES

Correcting a vitamin A deficiency has little of the instant, dramatic impact that, for example, vitamin C has in curing scurvy.

Because of the body's ability to store quantities of vitamin A which are released as needed, a considerable time passes before the vitamin A deficiency develops.

Lack of enough vitamin A shows itself in several ways.

"Dark adaptation" of the eyes is diminished. Go from a brightly lighted place to one which is dim or dark; notice how your eyes need a few moments to adjust. This is known as *dark adaptation*. With vitamin A deficiency, the power of the eyes to make the adjustment quickly and completely is lessened, sometimes severely or dangerously.

The skin, too, becomes dry from lack of vitamin A. The linings of the hair follicles harden and become plugged, thus interfering with the secretion of the skin's oil glands.

Other epithelial tissues, such as the linings of the upper parts of the respiratory passages, the genito-urinary tract, the alimentary canal, may not function properly.

Vitamin A is necessary for growth. When children fail to gain weight a deficiency of the vitamin may be suspected.

Physicians treat the deficiency states with therapeutic doses of the vitamin. To prevent their development or recurrence they may prescribe supplementary dosages.

MICROGRAMS, U. S. P. UNITS, INTERNATIONAL UNITS

The measurement of vitamin A is made in *International Units* which may be abbreviated as I.U. or i.u.

One International Unit of vitamin A is equivalent to:

— 0.344 microgram of crystalline vitamin A acetate.
— 0.300 microgram of crystalline vitamin A alcohol.
— the activity of 0.6 microgram of pure beta carotene.
— one U. S. P. unit of vitamin A.

In everyday measurement, one ounce equals 94,500,000 International Units of vitamin A alcohol.

Vitamin A is available to pharmaceutical and food manufacturers in forms having standardized potencies as, for example, liquid products containing 1,000,000 units per gram or dry beadlets having 250,000 or 500,000 units per gram.

MEASURING VITAMIN A

The best known and most commonly used method of measuring vitamin A is the Carr-Price spectrometric assay. In this chemical test a measurable blue color appears when a reagent (antimony trichloride) is added to the vitamin. The so-called "blue value" when measured photometrically can be converted by a mathematical formula into International Units of vitamin A.

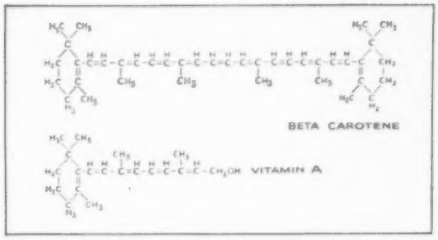
PROVITAMIN AND VITAMIN

The carotenes and vitamin A are known to be closely related. The former are known as precursors, or *provitamins*. It is one of nature's singular facts that the carotenes contain no vitamin A and yet have important vitamin A value. The body has a mechanism by which carotene is converted to vitamin A.

Four carotenoids: alpha-, beta-, and gamma carotene, and cryptoxanthin are known to be provitamins A. Of these, beta carotene is the most valuable in supplying the vitamin's value. The carotenes exist as colors in vegetable material. Example: carrots from which the word "carotene" was derived.

The chemical formulae of the carotenes show their relationship to vitamin A. This is demonstrated in the diagram that follows showing vitamin A and beta carotene.

Theoretically, one molecule of beta carotene could be expected to yield two of vitamin A. Actually this efficiency of conversion is not normally achieved in the human body.



GOOD SOURCES

Margarine, which has been fortified with vitamin A or with a combination of the vitamin and beta carotene (for safe coloring, plus nutritional value) supplies important amounts in our daily diet. Butter, too, can be a valuable source. It contains vitamin A in quantities which vary as the dairy cows' diet varies between seasons. Another good source of vitamin A is beef or calves' liver.

There are many foods which contribute vitamin A value through their supplies of the carotenes. Among these are apricots, beet greens, broccoli, carrots, kale, spinach, sweet potatoes, and turnip greens.

MOSTLY, IT'S MADE

After the chemical composition was determined by Paul Karrer and the product was crystallized by Holmes and Corbett, many attempts were made to synthesize the vitamin. The most successful, that of the Roche research team headed by Otto Isler, supplies a large portion of the world's requirements.

Vitamin A is also extracted from natural sources such as the liver of fish. Esthetically and practically, however, synthetic vitamin A has been found the most satisfactory for products used by human beings.

The U. S. production of synthetic (man-made) vitamin A is measured in tons. This huge annual production is enough to supply daily 170,000,000 people, the total population of the United States, with the 5000 international units (recommended by the National Research Council for daily adult intake) and still have enough synthetic vitamin A left over for use in animal feeds, pet foods, for export, etc. Of course, not everyone does receive his daily requirements through the medium of manufactured vitamin A. Yet, the *potential* is always there.

Pure beta carotene, so closely allied with vitamin A, also is man-made in large amounts for use in safely coloring and fortifying foods. Since it was first synthesized in Roche research laboratories, beta carotene Roche has been produced in ever-increasing quantities to meet the demands of the food industry for safe, sure, economical, yellow color with nutritional value as a bonus.

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Aluminum Foil Packaging –Vacuum Packaging

Report No. 20 of a Series by Reynolds Metals Co.

Of all methods of flexible packaging, only the vacuum pack approaches the ultimate in the protection it provides. Used for foods and other products subject to deterioration and spoilage, vacuum packaging in its complete form provides by far the greatest protection against moisture loss or gain, oxidation, chemical change or decomposition and bacterial changes. It assures to the consumer higher quality maintained over a shelf life many times longer than is possible with products not vacuum packaged.

To achieve its high potential, vacuum packaging must have perfection in the material used. The material must be impermeable to water vapor, oxygen and gas permeability. It must maintain this impermeability under varied conditions—high and low temperatures, high and low relative humidities. In flexible packaging, these extreme specifications can be met only with aluminum foil as a component of the material used. And aluminum foil also provides impermeability in another useful sense. It is completely opaque—excluding light rays that can cause losses of vitamins, nutrients, flavor and color.

Various Foil Materials

Aluminum foil vacuum packaging materials include laminations to such heat-sealing films as Saran, Vinyls, Pliofilm and Polyethylene. Extra strength or use characteristics can be provided by adding Mylar,* cellulose acetate film, cellophane, paper or fabrics. Other vacuum packaging materials can be made by extrusion coating of aluminum foil.

With these many combinations of materials, various processes can be used. After the evacuation, essential for the removal of all oxygen, it is sometimes advisable to add nitrogen or other inert gas at atmospheric pressure. Also, the possibility of sterilization methods in processing and packaging is to be considered where straight vacuum packaging is not sufficient to prevent bacteria or mold growth—as in packaging meats and other foods high in moisture content. Many other foods can be vacuum packaged indefinitely if they are dry or dehydrated or if they contain a sufficient concentration of salt or other preservative.

Again, the length of storage life depends upon the moisture, gas and oxygen permeability of the package. Laboratory tests have shown that powdered whole milk, coffee, dehydrated meats and vegetables will keep more than two years without loss of quality when vacuum packaged in aluminum foil laminated pouches.

Explanation of Chart

The graph shows typical permeability or vacuum retention properties of three materials used as pouches for vacuum packaging of sliced luncheon meat. All were packed at a vacuum of 29 inches of mercury. Loss of vacuum was measured weekly for four weeks. Note that the pouches with aluminum foil, materials 1 and 2, maintained a vacuum of over 28 inches throughout the four-week test, while the non-foil material lost nearly 4 inches of vacuum. In the same study, the meat in the foil vacuum package, when stored at 40° F., was normal in color, odor and appearance after 40 days, whereas the meat in the non-foil package stored under the same conditions retained its normal color, odor and appearance for only 20 days.

An additional advantage of flexible vacuum packaging over other forms is the saving obtained in weight and in space.

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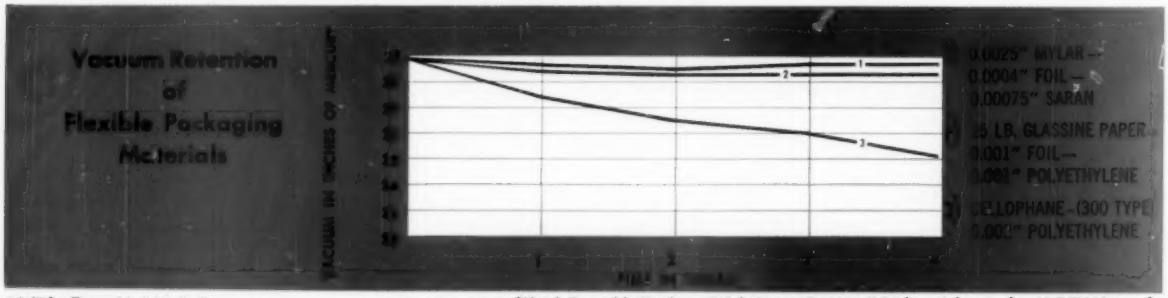

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levels. When no such differences are found, the product of the filler is sampled at random to establish one standard of conformance for the entire machine. When out-of-control fills are known to reflect individual filling-head characteristics, the heads must be either adjusted to the same process level or standards of conformance must be set for each filling-head and separate extreme value charts plotted for each head during the commercial operations. This latter procedure, although it is the most exact statistical solution, is a costly one. The following modification is suggested to balance cost against statistical efficiency:

(1) set the filling heads to operate as close as possible to the same process level;

(2) select a sub-group size equal to, or a multiple of, the number of filling-heads;

(3) from a capability study, calculate the standards of conformance for underfills and overfills based on the normal variation between filling-heads and the variation within heads;

(4) in commercial filling operations, again select a sub-group size equal to the number of filling-heads and select one sample from each filling-head at each sampling period;

(5) at each sampling period, plot the smallest value in the group on the chart for underfills and the largest value on the chart for overfills; if possible, record the filling-head identification beside each point on the charts.

If one particular filling-head is consistently high or low, this condition will be quite obvious on the extreme value charts. If points go out of control, the maverick filling-head is adjusted at the earliest possible shut-down. Even if samples cannot be identified on the charts in regard to filling-head origin, the assignable cause of out-of-control points is likely to be one specific filling-head; the maverick head is then located when the machine is shut-down.

CHECKWEIGHING REJECTION LIMITS

The rejection limits for sample checkweighing are calculated from a filling machine capability study by incorporating the variation in filling weights within a head with the variation in filling weights among the different filling-heads so that the total machine variation is obtained. This total filling machine variation is then used to calculate the control limits for the minimum and maximum extreme filling weights in the usual manner for samples of a given size, based on the average range. The average range is calculated from the total variation by means of the familiar relationship:

$$\bar{R} = d_2 \sigma_T \qquad (6)$$

where: d_2 = a factor dependent on sample size (3)

σ_T = total variation of the filler

The product emerging from the filler is sampled at stated intervals of time or of production. The sample, 6 containers for example, is then checked for the maximum and minimum extreme filling weights. For the sample to be acceptable, the underfill and the overfill must be within the established limits.

Rejection limits for automatic check weighers which 100% inspect the output of a filling machine are based on the specification limits for individual samples. However, these specification limits are realistic only when the filling and packaging equipment are capable of operating within the extreme value control limits. If such is the case, then the results from a filling machine capability study are used to set the limits for the automatic checkweigher. If the filling equipment is not capable of operating within the extreme value control limits, then the automatic checkweigher is merely inspecting quality into the process by rejecting an excessive proportion of the product.

SUMMARY

Extreme value control charts are designed to control actual maximum and minimum sample values, rather than averages or ranges; however, they are not universal substitutes for the conventional average and range charts.

In processes such as filling, where emphasis is placed on controlling over- and underfilling, this method of quality control charting gives excellent results. It provides rational tolerances for underfills and overfills, sets a standard of conformance for direct control of these operations, and aids in establishing realistic rejection limits for sample or automatic checkweighing so that these limits are directly related to filling or packaging capability.

Acknowledgment

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The Influence of High Temperature Holding Upon the Components of Coffee Brew[a, b]

(Manuscript received June 9, 1958)

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THE EFFECT of temperature on coffee flavor has attracted the attention of the industry, particularly with the development of instant coffee. Users of large quantities of freshly brewed coffee often need to hold a batch at elevated temperatures for some time before it is completely consumed, or add the last portion of an old batch to a freshly brewed coffee. In either case, the quality of the brew is lowered.

This study was undertaken in an attempt to evaluate the nature and extent of flavor deterioration in coffee brew subjected to elevated temperatures and to explore the behavior of some of the chemical compounds found therein.

It is common knowledge that many of the flavoring compounds used by other industries were carbonyl compounds of the ketone or aldehyde type. Hughes and Smith *(12)* recognized that it was quite possible that these compounds might play an important role in the flavor of coffee. These authors studied the loss on roasting and the loss upon holding the roasted beans of several carbonyl compounds reported present in coffee. The behavior of these compounds in coffee brew, however, has been left to speculation.

The literature on the chemistry of coffee is extensive. There are numerous references to chlorogenic acid *(1, 5, 7, 8, 21, 22, 27, 28, 32)* to other important acids *(2, 3, 4, 10, 11, 18)* to the phenomena of staling *(23, 24, 25)* and to analytical methods specific for the constituents of coffee.

EXPERIMENTAL

Standard coffee brew was prepared from a blend of coffee composed of 30% Santos (Brazil), 35% Armenia (Columbia), and 35% Mara (Venezuela).

A drip-coffee brew with redistilled water was prepared according to the recommendations *(17)* of the Coffee Brewing Institute (85 g. of coffee plus 1330 ml. of water).

Standard experimental conditions were chosen as the holding of coffee brew at 63° C., 73° C., 83° C. and 93° C. for 0, 1, 3, 6 and 24 hours.

Determinations for pure water solutions of caffeine, trigonelline, chlorogenic acid, and caffeic acid were carried out by Beer's Law Calculation from the ultraviolet absorption spectra of the compounds. Pure water solutions of these compounds were subjected to standard holding times at 83° C., and the recovery of each compound calculated.

The recovery of carbon-dioxide from the pyrolysis of quinic acid in water solution was determined by the method of Proctor, Lockhart and Goldblith *(26)*.

The measurement of caffeine in coffee brew was carried out by the method of Ishler, Finucane and Borker *(14)*, using 20 ml. samples of standard coffee brew.

Trigonelline was measured by the method of Moores and Greniger *(20)*, using a 1/10 dilution of standard coffee brew, and chlorogenic acid was determined by the method of Moores, McDermott, and Wood *(21)*, using a 2/5 dilution of standard coffee brew.

Organoleptic studies were conducted by means of an incomplete randomized block design. Judges were given a freshly prepared reference sample with which the test samples were compared. The simple hedonic (1 to 9) rating scale was used for scoring. Each judge was presented with a freshly prepared reference sample and two test samples which had been subjected to a given holding time but at different temperatures. The data obtained were tested for significance at the 99% confidence limits *(29)*.

Pure carbonyl compounds held in water solution at 83° C. for 0, 1, 3, 6 and 24 hours, as well as total saturated and unsaturated carbonyl compounds in coffee brew were determined by a modification of the method of Henick, Benca and Mitchell *(9)*. For water solutions of pure carbonyls, extraction was made from water with benzene. For coffee brew, benzene was also the extracting agent.

RESULTS AND DISCUSSION

The results obtained from the organoleptic studies (Table 1) showed the following pattern: Coffee brew held for as little as one hour, regardless of the temperature, was scored significantly lower than the freshly prepared control samples. Thus, the importance of serving brewed coffee as soon after preparation as possible can be seen.

It was noted that the mean hedonic rating for coffee brew held one hour was highest at the highest holding temperature.

The fact that the highest hedonic rating, after one hour of holding, was obtained for the coffee brew held at the highest temperature, seemed strange since the reverse was true for all other holding times. In cases where the brew was held for 3, 6, and 24 hours, the lowest rating was always given to the sample held at the highest temperature.

The possibility that some tasters might prefer hot coffee to lukewarm coffee was precluded since the serving temperature for all samples was the same (63° C.).

TABLE 1

Organoleptic analysis of standard coffee brew (Mean hedonic rating at $t_{.01}$ level)

Time of holding (hrs.)	Holding temperature (° C.)			
	63	73	83	93
0	7.36 ± .16	7.36 ± .16	7.36 ± .16	7.36 ± .16
1	6.17 ± .35	6.12 ± .40	6.34 ± .40	6.84 ± .26
3	6.23 ± .28	5.72 ± .51	6.00 ± .52	4.89 ± .36
6	4.77 ± .37	5.00 ± .47	3.84 ± .36	3.98 ± .39
24	2.78 ± .29	2.39 ± .33	2.72 ± .39	2.00 ± .23

[a] Presented at the Eighteenth Annual Meeting of the Institute of Food Technologists, Chicago, May 28, 1958.

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These data show that freshly prepared coffee brew was unquestionably preferred to coffee brew held for any length of time at any holding temperature. The mean hedonic rating of 7.36 ± 0.16, when the highest possible rating is 9.0, indicated that this initially was good coffee.

Studies indicated that hexaldehyde butyraldehyde and acetone (Table 2) were all unstable in pure solution when held at 83° C. for various periods of time up to 24 hours. The data indicated a rapid loss of the carbonyl compound in the first hour, followed by a slower rate of loss over the next few hours, up to 24 hours.

The results of carbonyl analyses in standard coffee brew are shown on Tables 3 and 4. It is possible that the relatively great loss of unsaturated carbonyl compounds after one hour at 93° C. compared with the losses at lesser temperatures coupled with the relatively higher organoleptic acceptance of this sample, is indicative of the formation of other flavor compounds. Further studies on the chemistry of unsaturated carbonyl compounds in coffee brew would be necessary to settle this question.

The behavior of the total unsaturated carbonyl compounds content of coffee brew was generally in agreement with the pattern established by the organoleptic analyses. The loss of these compounds was found to be greater at the longer holding times and at the higher temperatures.

The effect of holding for one hour at elevated temperature was to increase the content of saturated carbonyl compounds (Table 4).

This is interesting because it marks a series of compounds whose content increases, for a time at least, with increasing severity of holding conditions. This matches the peculiar pattern found in the organoleptic analyses for the one-hour samples. The fact that the saturated carbonyl compounds continue to rise after the organoleptic scores begin to fall indicates that this would not be solely responsible for the flavor phenomena.

The increase of total saturated carbonyl compounds in coffee brew as opposed to decreases in studies of pure solutions of saturated carbonyl compounds, needs some explanation. When coffee brew is subjected to high temperatures, it is possible that a breakdown of some long chain compounds occurs. The result of this breakdown could possibly be the formation of large quantities of saturated carbonyl compounds, as evinced by the early increases found in these studies.

After continued heating, the large quantity of unsaturated compounds would become exhausted and the rate of formation of new saturated carbonyl compounds would necessarily drop off. The destruction of

TABLE 2

Recovery of carbonyls from water solution (Holding temperature, 83° C.)

Time of holding	Carbonyl added	Carbonyl recoverable in a single extraction	Carbonyl recovered in a single extraction	Recovery
(hrs.)	*(u-g./ml.)*	*(u-g./ml.)*	*(u-g./ml.)*	*(%)*
0[1]	52.4	26.9	27.1	104.5
1	52.7	27.1	15.0	55.4
6	51.7	26.6	13.0	48.9
24	52.7	27.1	12.6	46.5
0[2]	41.8	20.9	19.6	94.0
1	40.7	20.3	15.7	77.5
3	41.7	20.5	13.1	63.9
6	41.8	20.9	13.1	62.6
24	41.8	20.9	8.1	38.8
0[3]	29.9	15.45	15.02	97.4
1	29.9	15.45	11.32	73.4
3	29.9	15.45	9.52	61.5
6	29.9	15.45	7.82	50.6
24	29.9	15.45	6.14	39.7

[1] Hexaldehyde, extraction coefficient = 0.513.
[2] Butryaldehyde, extraction coefficient = 0.500.
[3] Acetone, extraction coefficient = 0.516.

TABLE 3

Recovery of total unsaturated carbonyl compounds from standard coffee brew (Total unsaturated carbonyl compounds)

Time of holding	Temperature of holding (° C.)							
	63		73		83		93	
	Std. brew	Yield at "O"	Std. brew	Yield at "O"	Std. brew	Yield at "O"	Std. brew	Yield at "O"
(hrs.)	*(u-mol./100 ml.)*	*(%)*	*(u-mol./100 ml.)*	*(%)*	*(u-mol./100 ml.)*	*(%)*	*(u-mol./100 ml.)*	*(%)*
0	52.9	.....	52.9	.....	52.9	.....	52.9	.....
1	47.0	89.0	52.0	98.3	44.7	84.5	32.0	60.5
3	38.5	72.9	41.0	77.5	45.4	85.7	34.0	64.3
6	38.5	72.9	31.0	58.6	42.4	80.0	32.0	60.5
24	35.5	67.2	31.0	58.6	15.5	29.3	21.0	39.7

TABLE 4

Recovery of total saturated carbonyl compounds from standard coffee brew (Total saturated carbonyl compounds)

Time of holding	Temperature of holding (° C.)							
	63		73		83		93	
	Std. brew	Yield at "O"	Std. brew	Yield at "O"	Std. brew	Yield at "O"	Std. brew	Yield at "O"
(hrs.)	*(u-mol./100 ml.)*	*(%)*	*(u-mol./100 ml.)*	*(%)*	*(u-mol./100 ml.)*	*(%)*	*(u-mol./100 ml.)*	*(%)*
0	11.5	.....	11.5	.....	11.5	.....	11.5	.....
1	17.5	152	12.0	104	17.5	152	16.0	139
3	21.5	187	13.5	117	16.5	143	10.0	87.0
6	15.0	130	16.5	143	17.5	152	9.5	82.5
24	9.5	82.5	14.0	122	4.5	39.1	9.0	78.2

the saturated carbonyls would continue and a net loss would show in time.

It is interesting to note that these results show general agreement with the findings of Hughes and Smith *(12)*. Further investigation of this subject might prove of value.

On the basis of the data obtained (Tables 5 and 6), it is evident that caffeine and trigonelline in coffee brew are completely stable under conditions as extreme as holding for 24 hours at 93° C. Therefore, it is highly unlikely that any deterioration in the flavor of coffee brew could be due to the destruction, loss, or chemical action of caffeine or trigonelline.

TABLE 5

Recovery of compounds from water solution (Holding temperature, 83° C.)

Time of holding	Added	Concentration of compound recovered	Recovery
(hrs.)		*(u·g./ml.)*	*(%)*
0[1]	800	790	99.0
1	800	788	98.6
3	800	796	99.6
6	800	788	98.6
24	800	800	100.0
0[2]	728	730	100.2
1	728	728	100.0
3	728	724	99.6
6	728	728	100.0
24	728	728	100.0
0[3]	292	292	100.0
1	292	289	99.0
3	292	287	98.3
6	292	284	97.2
24	292	274	93.8
0[4]	196	195	99.7
1	196	188	96.0
3	196	180	91.9
6	196	173	88.2
24	196	152	77.6

[1] Caffeine. [2] Trigonelline. [3] Chlorogenic Acid. [4] Caffeic Acid.

TABLE 6

Recovery of caffeine and trigonelline from standard coffee brew (Holding temperature, 93° C.)

Time of holding	Concentration of compound std. brew	Compound found at "O" time
(hrs.)	*(u·g./ml.)*	*(%)*
0[1]	581	.....
1	579	99.7
3	580	99.9
6	580	99.9
24	581	100.0
0[2]	780	.....
1	785	100.5
3	784	100.3
6	785	100.5
24	787	101.0

[1] Trigonelline. [2] Caffeine.

The content of chlorogenic acid in the standard coffee brew was found to vary with the length of time and the temperature at which the brew was held (Table 7). The degree of loss increased with the increase in temperature.

The determination of caffeic acid in pure solution indicated that it disappeared in direct relation to the time and temperature at which the solution was held (Table 5). It was noticed that there was a definite development of a yellow-brown color, which increased in intensity in proportion to the length of the heating period. It may be due to complete breakdown of the end-products of the caffeic acid deterioration, tetrahydroxycyclohexane and dihydroxystyrene *(30, 31)*.

The similarity between the ultraviolet absorption spectra of chlorogenic and caffeic acid may indicate that the ultraviolet absorption properties of chlorogenic acid are due to the caffeic acid part of the molecule, since quinic acid, the other half of the chlorogenic acid molecule, has no ultraviolet absorption spectrum.

When pure chlorogenic acid was subjected to holding for 24 hours at 83° C., the loss was 6%. When chlorogenic acid was determined in coffee brew, the loss was 15%.

One explanation for the greater loss in coffee brew than in pure solution may lie in the possibility that there are substances in coffee brew which further decrease the stability of chlorogenic acid.

Another explanation for this difference is concerned with the method of determination itself.

The determination of chlorogenic acid is based upon two properties of the acid: Upon the ultraviolet absorption of that compound at a wavelength of 324 mμ, and upon the removal of the chlorogenic acid from solution by precipitation as the lead chlorogenate.

It has been determined that caffeic acid has an ultraviolet absorption spectrum which is similar to that of chlorogenic acid. Caffeic acid reacts towards basic lead acetate in much the same manner as does chlorogenic acid *(21)*. For these reasons, it is quite possible that this determination has also included caffeic acid.

There is also a possibility that the method has included some iso-chlorogenic acid, an optical isomer of chlorogenic acid. The chemistry of this compound is not well known and only recent reference has been made to its presence in coffee *(1)*. Moores *et al. (21)*

TABLE 7

Recovery of chlorogenic acid from standard coffee brew (Concentration of chlorogenic acid)

Time of holding	Temperature of holding (° C.)							
	63		73		83		93	
	Std. brew	Acid at "O"	Std. brew	Acid at "O"	Std. brew	Acid at "O"	Std. brew	Acid at "O"
(hrs.)	*(u·g./ml.)*	*(%)*	*(u·g./ml.)*	*(%)*	*(u·g./ml.)*	*(%)*	*(u·g./ml.)*	*(%)*
0	2450	.....	2450	.....	2450	.....	2450	.....
1	2360	96.4	2370	96.8	2430	99.4	2410	98.5
3	2270	92.6	2270	92.6	2300	94.0	2270	92.6
6	2180	89.0	2160	88.2	2170	88.5	2060	84.1
24	2150	87.8	2120	86.5	2080	85.0	1980	80.9

noted that the method they have developed for the determination of chlorogenic acid is based upon pure chlorogenic acid. They stated quite frankly that they have neglected the possibility of isomeric forms of chlorogenic acid, and of free caffeic acid, in their studies.

The evolution of carbon dioxide from quinic acid pyrolysis was determined for solutions of quinic acid held at 83° C. for up to 24 hours. No carbon dioxide was obtained.

The decarboxylation of quinic acid was not effected by experimental conditions. From this standpoint, the compound showed itself to be unaffected by holding at elevated temperature.

SUMMARY AND CONCLUSIONS

Coffee brew was found to undergo measurable flavor deterioration when held at elevated temperatures for various lengths of time. This deterioration was most rapid at higher holding temperatures for coffee brew held longer than one hour. Coffee brew held at elevated temperature for up to one hour retained its flavor best when the holding temperature was highest (93° C.).

The saturated carbonyl compounds content of coffee brew was found to rise with increasing length and temperature of holding. This is a possible indication of the formation of this type of compound from some substance in coffee brew.

The unsaturated carbonyl compounds content of coffee brew was observed to decrease with increasing severity of treatment. This points out the possible role played by this type of compound in the flavor and flavor changes, which are associated with coffee brew.

Caffeine and trigonelline were found to be stable under the most severe holding conditions used in these studies. It is unlikely that these compounds play more than a minor role in the changes in flavor which take place when coffee brew is subjected to high temperatures for extended periods of time. This does not imply that caffeine and trigonelline are not important contributors to the initial flavor experienced by the tasting of freshly prepared coffee brew. It may be that these compounds are modified in their astringent or bitter taste characteristics when present together with the other flavoring compounds of fresh coffee brew. As the more delicate flavor components undergo change, the relatively stable caffeine and trigonelline may form a larger proportion of the remaining flavor compounds and, therefore, contribute indirectly to the increase in astringent and bitter off-flavors which have been reported to develop.

Chlorogenic acid is somewhat unstable in coffee brew held at the standard experimental conditions. This instability generally follows the pattern of increase with higher temperatures and longer holding times. For this reason, it appears that chlorogenic acid may play an important role in the flavor changes in coffee brew.

Studies on caffeic acid in water solution indicate that this compound exhibited marked instability when subjected to standard experimental conditions.

Quinic acid was stable in water solutions held under standard test conditions. If this compound is indeed present in coffee brew in the free state, it is unlikely that it contributes in more than a minor way to the flavor changes which take place.

Acknowledgment

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Processing Conditions Affecting the Yield of Tomato Juice[a]

(Manuscript received July 26, 1958)

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In the course of pilot plant studies on tomato juice manufacture *(1, 2)*, certain processing conditions were found to affect the yield and consistency of the juice. In particular, the paddle-type finisher, as a result of its influence on the amount of suspended solids, exerted a profound effect on the gross viscosity, degree of settling, and yield of the juice.

The yield of tomato juice is reduced by losses at three principal locations: in the washer, on the trimming table, and at the finisher. When a vibratory screen is used in the production line a further loss of yield is introduced. Losses at the first two of these locations are directly related to such qualities of the raw material as softness and amount of decay and the processor has little control over these losses. However, losses at the vibratory screen and the finisher are subject to conditions of processing such as the preheating temperature and the speed of the finisher. The processor can at least adjust his conditions to keep these losses at a minimum insofar as this is consistent with quality.

EXPERIMENTAL

The pilot plant used for these studies has been described previously *(2)*. A minimum lot of tomatoes was about 100 pounds. After each lot the plant was stopped, the product and all refuse fractions were weighed, and the lines were cleaned out before the next lot was introduced. The yield was determined by weighing the canned juice and accounting for the "tailings" at the beginning and the end of each run. Since the tailings were diluted with water, they were caught in a weigh tank, agitated thoroughly, and analyzed for total solids. From this figure the equivalent amount of juice in the tailings could be calculated.

Experiments have been conducted with 3 types of finishers: a laboratory model paddle-type finisher,[c] a tapered screw-type extractor,[d] and an eccentric drum-type extractor.[e]

RESULTS

Effect of type of finisher and preheating temperature on over-all yields. Data summarized in Table 1 include the results of all comparable experiments during the 1950, 1951, and 1952 seasons. It is evident that both type of finisher and preheating temperature influence yields. Lowest yields are obtained with the cold-break juice, and the highest were obtained at intermediate preheating temperatures. The observed yields range from 29.4 to 91.5%. At intermediate temperatures the average yield from the screw-type extractor was 78.9% and from the paddle type, 82.4%. These yield data must be considered illustrative of relative values. Under commercial operating conditions, the absolute yield might vary with equipment adjustments. A given speed in r.p.m. for a small pilot plant finisher is not comparable to the same speed in r.p.m. for a commercial unit, since the blades of a large finisher are travelling much faster than those of a small finisher at the same r.p.m.

Effect of paddle finisher speed, screen size, and preheating temperature on finisher waste. The amount of waste at the paddle-type finisher passes through a minimum in the range of 130 to 170° F. The significance of this effect on yield is shown in Figure 1. It appears that the yield of juice is more sensitive to preheating temperatures at low paddle-finisher speeds. When

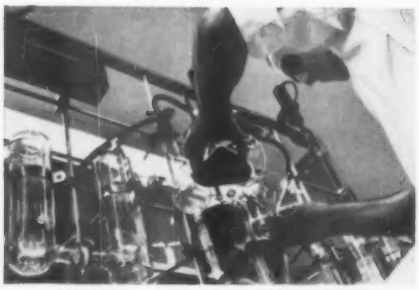
[a] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 948.

[b] Present address: Bedford Products Company, Dunkirk, New York.

[c] F. H. Langsenkamp Co., Indianapolis, Indiana. Catalog No. 48, p. 27.

[d] Chisholm-Ryder Co., Niagara Falls, New York. Catalog No. 51, p. 54.

[e] F. H. Langsenkamp Co., Indianapolis, Indiana. Catalog No. 46, p. 43.



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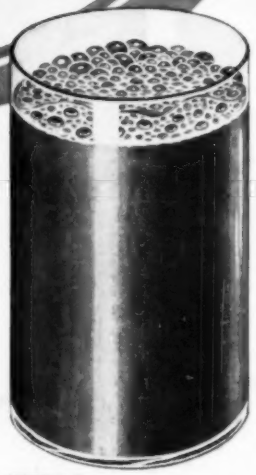

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finisher speed and screen size are the same (Table 2), the losses at the finisher are less at a preheating temperature of 160° F., than at either 70° F., or 200° F. Finisher losses can be reduced at any of the preheating temperatures by speeding up the action of the finisher. Further gains obtained by the use of screens coarser than 0.023 in. were offset by the appearance of defects (as specks) in the juice.

The improvement in yield obtained by speeding up the action of a paddle-type finisher is accompanied by an increase in the viscosity of the juice. At 1600 r.p.m. the viscosity is considerably higher than that of commercial juice *(1)*. An inverse relation exists between the per cent of finisher refuse and the gross viscosity of tomato juice (Figure 2).

Effect of preheating temperature on losses at vibratory screen. Losses at the vibratory screen[6] are influenced by the preheating temperature and are higher at temperatures below 130° F. Increasing the preheating temperature above 140° F. has little or no effect on losses at the vibratory screen. Table 3 gives the results of two experiments showing the amount of refuse obtained from the screen, expressed as per cent of the original tomato weight. The increased losses at the screen at the lower preheating temperatures are caused by the chopped tomatoes being firmer at these temperatures. Consequently they are not so readily shaken through the openings in the screen. This observed effect has no practical bearing on yield since it does not apply to the range of temperatures used commercially. The tomatoes in Test 2 were graded No. 2 for lack of color. These tomatoes, being less ripe, were firmer than the No. 1 tomatoes of Test 1, and therefore, losses on the screen were slightly higher.

TABLE 1

Effect of preheating temperature and type of finisher on yield of juice [1]

Preheating temperature	Type of finisher	No. of lots	Yield of juice		
			Min.	Max.	Average
°F.			%	%	%
70	Paddle[2]	12	60.0	79.0	72.7
130–170	Paddle[2]	45	71.8	91.0	82.4
200	Paddle[2]	10	73.7	87.3	79.6
70	Screw[3]	4	29.4	74.8	51.1
130–170	Screw[3]	5	73.8	85.5	78.9
200	Screw[3]	5	49.7	85.5	67.7
70	Roller[4]	3	72.0	82.1	78.4
130–170	Roller[4]	3	83.1	91.5	88.4
200	Roller[4]	2	75.3	83.4	79.3

[1] Yield from all comparable experimental lots put up in the pilot plant during the 1950, 1951, 1952 seasons.
[2] Paddle-type finisher 400 to 900 r.p.m., finisher screen .020 in. or .023 in.
[3] Tapered screw extractor, 280 r.p.m., .020 in. screen.
[4] Eccentric drum extractor, 190 r.p.m., .023 in. screen.

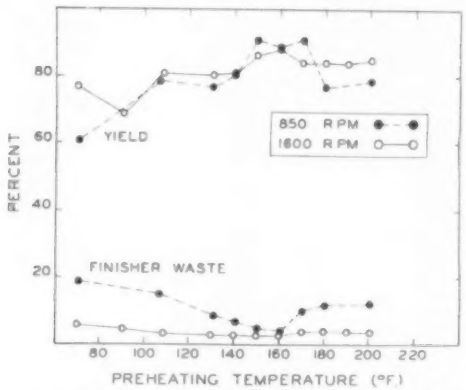

Figure 1. Effect of preheating temperature and finisher speed on juice yield and finisher waste.

TABLE 2

Effect of finisher speed, preheating temperature, and screen size on the per cent waste at finisher [1]

Process date	Finisher speed	Finisher screen size	Per cent waste at:		
			70° F.	160° F.	200° F.
	r.p.m.	*inches*			
9/10	200	.023	30.1	12.8	26.1
9/10	400	.023	14.6	6.4	13.0
9/10	800	.023	11.2	4.1	10.5
9/10	1600	.023	7.8	7.1	8.7
9/24	200	.023	32.2	16.2	19.3
9/24	200	.033	22.6	9.9	19.5
9/24	200	.045	21.2	9.6	14.9
9/24	200	.060	19.0	9.7	16.0
9/11	800	.023	11.5	6.0	9.5
9/11	800	.033	9.1	3.8	7.0
9/11	800	.045	8.3	3.3	5.9
9/11	800	.060	7.5	2.4	5.8
9/23	1600	.023	6.9	2.9	4.1
9/23	1600	.033	6.0	2.1	3.6
9/23	1600	.045	5.2	2.4	3.2
9/23	1600	.060	4.4	2.3	2.2

[1] 1952—Red jacket tomatoes, no vibratory screen, Langsenkamp paddle finisher.

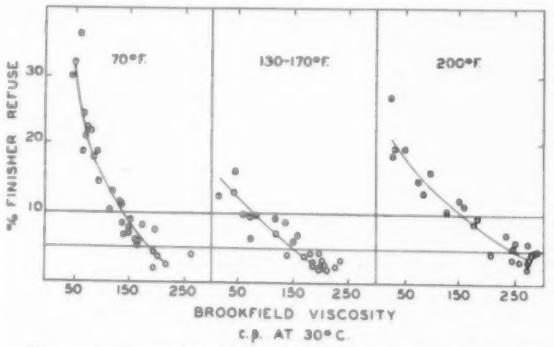

Figure 2. Gross viscosity vs. finisher refuse at three preheating temperatures. Paddle type finisher. Finisher refuse varied largely by changing paddle speed (200 to 1600 r.p.m.).

TABLE 3

Effect of preheating temperature on screen refuse [1]

Preheating temperature	Screen refuse	
	8/31/51 Test 1	9/13/51 Test 2
	%	%
70	....	11.2
80	9.7	....
100	6.1	8.2
130	5.6	....
140	4.1	5.9
150	5.1	5.7
160	3.6	5.7
170	4.6	5.5
180	4.6	6.6
200	5.1	6.5

[1] Test 1: No. 1 tomatoes. Test 2: No. 2 tomatoes (under color). Variety: Red jacket.

DISCUSSION

The observed relationship between yield and consistency aids in the selection of optimum manufacturing conditions. The object is to get the highest

[6] Overstrom and Sons, Inc., Alhambra, California.

yield possible without producing too viscous a juice. For example, if a gross viscosity of 150 centipoises is desired, it may be attained at all preheating temperatures with an 0.023-inch screen. At 70° F. the paddle-finisher refuse would be 10% ; at 150° F. the finisher refuse would be about 6% ; and at 200° F. about 12% (Figure 2). If a lower viscosity is desired, the choice of preheating temperature would be 150° F. in order to obtain the maximum yield. If juice of extremely high viscosity is desired, it would be advisable to go to a higher preheating temperature, and to run the finisher at high speed.

As is well known in the industry, high yields are obtained when the finisher is adjusted to give a relatively dry waste. Low yields result from loss of the aqueous phase, or "serum." This is obvious when one considers the fact that 99.4% of the juice by weight is serum. The suspended solids contribute much to quality *(3)* but little to yield. The conditions of finishing which conserve the greatest amount of serum also result in the highest percentage of suspended solids in the juice.

SUMMARY

The yield of juice from commercial lots of tomatoes was studied on a pilot plant basis and found to vary from 29.4 to 91.5%. Excluding the losses suffered during washing and trimming which are a reflection of raw product quality, the greatest variation in yield occurred in the extraction operation where the skins and seeds are separated from the juice. Of the three methods of extraction tested (revolving paddle, tapered screw, and eccentric drum), the paddle finisher provided the widest range in yields.

The temperature to which the chopped tomatoes were preheated affected the efficiency of extraction. Temperatures in the range of 140 to 160° F. gave the highest yields. When tomatoes are preheated to 200° F. or higher, the speed of a paddle finisher must be increased to maintain satisfactory yields, but this produces extremely viscous juice. When a paddle-type finisher is used, the viscosity and yield of tomato juice are proportional to paddle speed.

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Radiation Preservation of Milk and Milk Products. IX.

Comparison of Bactericidal Effects of Cathode Rays, Gamma Rays and Ultraviolet Light[a, b]

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(Manuscript received May 31, 1958)

A major problem to be solved before cold sterilization can become a practical process for preserving foods is that of the disagreeable off-flavors produced by irradiation. This problem is of particular concern in milk, since undesirable off-flavors are detected therein when one one-hundredth of the radiation dose required for complete sterilization is applied. The radiation-induced off-flavor problem must therefore be solved before cold sterilization of milk can be considered practical.

Early in the work on radiation preservation of milk, the importance of quantitatively establishing the dose levels at which off-flavors are first perceptible—that is, the recognition threshold dose—was recognized. This information is necessary before attempts to avoid the production of radiation induced off-flavors can be evaluated.

Off-flavor recognition threshold doses for milk and cream irradiated with high-voltage cathode rays were determined by Bierman, Proctor, and Goldblith *(3)*. It was found that raw whole milk could withstand radiation up to 13,500 rep before off-flavor was noted. This result was surprising in view of the earlier work of Gaden, Henley, and Collins *(6)*, who reported the

[a] Presented at the Eighteenth Annual Meeting of the Institute of Food Technologists, Chicago, May 26, 1958.

[b] Contribution No. 352 from the Department of Food Technology.

recognition threshold dose of raw whole milk irradiated with 2 M.e.v. x-rays, to be 73,000 roentgens. In view of the significant difference between these two values it appeared worthwhile to investigate possible reasons for the observed lack of agreement.

Two causes of disagreement may have been (a) differences in organoleptic techniques used by the two groups for evaluating the off-flavors present and (b) fundamental differences in the reactions of cathode rays and x-rays with the components of milk.

It was considered possible that the linear ion density (LET) of the two radiations might differ sufficiently to cause different recognition threshold doses to be observed. It was also considered reasonable to propose that if such a fundamental difference existed between radiation with cathode rays and x-rays, a similar difference might be observed between cathode rays and gamma rays. A program was therefore undertaken to determine, by means of identical organoleptic techniques, the off-flavor recognition threshold doses of cathode rays and gamma rays. It was hoped that in this manner the differences in recognition threshold doses from cathode rays and x-rays could be clarified.

This investigation also includes the determination of recognition threshold doses of mercury resonance radiation, a non-ionizing radiation. It was reported by Albrecht, Gunning, and Parker *(1)* that such ultraviolet radiation caused virtual sterilization of raw whole milk without producing undesirable off-flavors. The present study was therefore extended and comparative data are now reported on the magnitude of off-flavors produced by (a) ultraviolet radiation, (b) gamma rays, and (c) cathode rays. The sterilization effectiveness of each type of radiation was kept equal.

EXPERIMENTAL

Materials. Certified raw whole milk of low bacterial count (less than 2000/ml.) was used as control in all organoleptic tests. Raw market whole milk with a bacterial count of approximately 10^5/ml. was used when the sterilization effectiveness of the various types of radiation was being evaluated.

Flavor evaluation techniques. The taste panel was composed of 25 judges selected from the departmental staff and students. All had had previous experience in threshold testing, in judging flavor quality, and in evaluating radiation-induced off-flavors in milk.

Calculation of threshold doses was carried out as described by Bierman, Proctor, and Goldblith *(3)*. The following thresholds were determined:

1. *Recognition threshold dose (RTD).* The dose of radiation which produces a radiation-induced off-flavor recognizable in 50% of the judgments over and above correct judgments expected by chance.
2. *Difference threshold dose (DTD).* The dose of radiation which produces a flavor difference detectable in 50% of the judgments over and above the correct judgments expected by chance.
3. *Flavor difference threshold concentration.* The concentration of irradiated milk which, when tested in unirradiated milk, causes a flavor difference detectable in 50% of the judgments over and above the correct judgments expected by chance.

The familiar "triangle test" was used for determining recognition threshold doses (RTD) and difference threshold doses (DTD). The "duo-trio" test was used to determine the flavor difference threshold concentration.

The percentage of correct judgments above chance was calculated as described previously *(3)* from the equation:

$$Pe = k\,(Po - Pe)$$

Pe is the percentage of correct judgments over and above chance, Po is the percentage of correct judgments observed in the test, Pe is the percentage of correct judgments obtained by chance, and k is a constant depending upon the type of binomial design used.

For the duo-trio test, Pe = 50%, since one-half of the judgments may be correct by chance, and $k = 2$. For the triangle test, Pe = 33.3%, since one-third of the judgments may be correct by chance, and $k = 3/2$. In the triangle test, if the judge is also asked to specify whether the odd sample has been irradiated, Pe becomes 16.7%, since one-sixth of the judgments may be correct by chance, and $k = 6/5$.

Radiation techniques. Gamma-radiation from the M. I. T. cobalt-60 source was used. Batches of 180 ml. of milk were irradiated in glass vessels.

Ultraviolet radiation was obtained from an Hanovia "Biosteritron" lamp in the manner described by Albrecht, Gunning, and Parker *(1)*.

Bacteriological methods. Standard bacteriological procedures were used for determination of the sterilization effectiveness of each radiation.

RESULTS AND DISCUSSION

Results of this work are given in Table 1. The difference threshold dose and off-flavor recognition threshold dose in raw milk for gamma radiations appear to be higher than the corresponding threshold doses found for cathode rays. These differences are not considered significant, however, since the doses found for both types of radiation fall within the confidence limits calculated by use of formulae of Eisenhart *(5)*, Bliss *(4)*, or Anderson and Bancroft *(2)*. These confidence limits are also given in Table 1.

The data in Table 1 are presented in summary form only. The actual panel testing performed in this work

TABLE 1

Threshold doses for raw whole milk exposed to gamma and ultraviolet radiations [1]

		95% confidence limits	
Gamma difference[2] threshold	12,700	9,100–13,500	$Y = -16.3638 + 3.9883X$
Off-flavor recognition threshold[3]	16,400	12,000–24,800	$Y = -14.8309 + 3.5190X$
Cathode Rays[5] difference[2] threshold	7,390	5,560–9,490	$Y = -4.3272 + 1.1186X$
Off-flavor recognition threshold	13,410	7,700–28,290	$Y = -5.0424 + 1.2217X$
Ultraviolet difference threshold[3]	1.11	87–1.37	$Y = -5.3123 + 2.5958X$
Off-flavor recognition threshold	1.45	3.20–0.98	$Y = -5.4250 + 2.5087X$

[1] Panel of 25 judges has been used through all the flavor tests performed.
[2] Dose expressed in reps.
[3] Dose expressed as rentention time in seconds per ml.
[4] Mathematically fitted best straight line of normal curve deviate (Y) corresponding to percentage above chance scores vs. log dose (X) on log-probability paper.
[5] Data from Bierman, Proctor, and Goldblith *(3)*.

was carried out over a period of one year using relatively large numbers of different samples of certified milk all obtained from the same producer. A minimum of 150 judgments was obtained for each dose experimented in order to determine the recognition threshold dose.

With the flavor difference threshold concentration, at least 5 dilutions were tested for each dose with at least 25 different panels of 25 people for each type of radiation studied.

The above figures are cited in order to give the reader some idea of the magnitude of effort and the thoroughness with which this work has been conducted.

Further evidence supporting the conclusion that no practical difference exists between cathode rays and gamma rays in their ability to produce off-flavors in milk, was provided by the similarity of the flavor difference threshold concentrations found in each case. These values are presented in Figure 1. This plot indicates that a given quantity of milk irradiated with a given dose of either cathode rays or gamma rays exhibits a similar intensity of off-flavor.

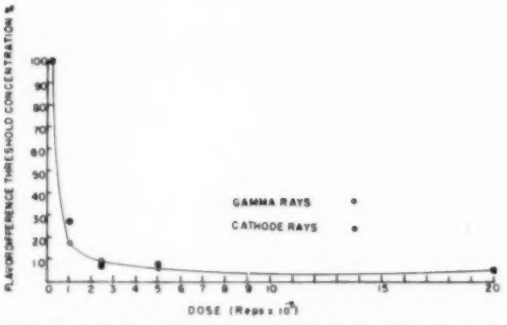

Figure 1. Flavor difference threshold concentrations (gamma and cathode rays).

Figure 1 also indicates that the flavor difference threshold concentration rapidly decreases as the radiation dose increases. In other words, due perhaps to breakdown products of milk competing for free radicals, the dose response curve becomes nonlinear at relatively low dose levels.

Albrecht, Gunning, and Parker *(1)* have reported that virtual sterilization of raw whole milk can be accomplished with ultraviolet radiation without the concurrent production of undesirable off-flavors. It therefore seemed worthwhile to repeat their work in order to compare the magnitude of off-flavors produced by ultraviolet radiation, a non-ionizing radiation, and by the ionizing radiations of gamma and cathode rays. It is well known that both ionizing and non-ionizing radiations cause destruction of bacteria as well as the production of off-flavors. There has been, however, no quantitative comparison of their effects.

It was considered that a comparison of the effects of ultraviolet and gamma radiation could best be accomplished by initially determining the bactericidal effectiveness of each type of radiation on raw whole milk.

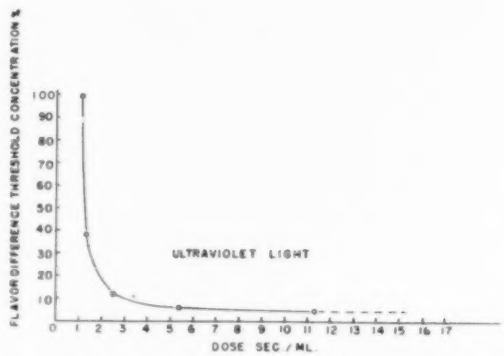

Figure 2. Flavor difference threshold concentration (ultraviolet light).

This was done and the results are illustrated in Figures 3 and 4. In the case of gamma radiation (Figure 3) the percentage of surviving bacteria is plotted as a function of the irradiation dose. In the case of ultraviolet radiation (Figure 4), the per cent survivors are plotted against the retention time in sec./ml. For example, a dose of ultraviolet radiation of 1.11 sec./ml. has about 90% bactericidal effect, and a dose of approximately 60,000 rep from gamma radiation is required for this same effect. In general, from the standpoint of bactericidal effectiveness each second per milliliter of retention time in the ultraviolet light beam is equivalent to a dose of 50,000 rep of ionizing radiation.

Relationship of the intensity of off-flavors produced during radiation to the two types of radiation under investigation was determined in the following manner. The difference theshold dose and the off-flavor recognition threshold dose for raw whole milk treated with ultraviolet radiation was determined. These values are shown in Table 1 where they may be easily compared with similar values for ionizing radiations. It is evident, by use of the difference threshold doses for

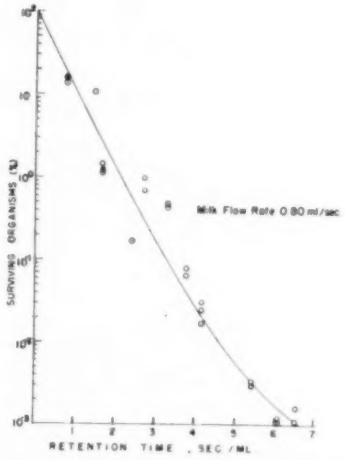

Figure 3. Surviving organisms, after gamma radiation, in relation to dose.

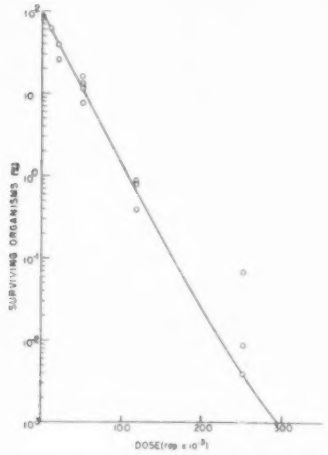

Figure 4. Surviving organisms, after ultraviolet radiation, in relation to retention time.

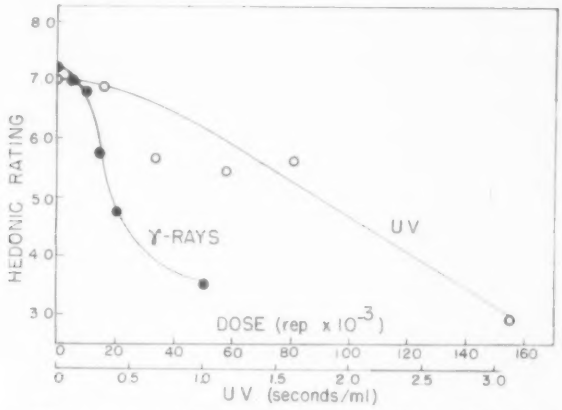

Figure 5. Hedonic ratings of gamma radiated and of ultraviolet radiated milks.

ultraviolet and gamma radiation given in Table 1 and the plots shown in Figures 3 and 4, that a difference threshold dose of 1.11 sec./ml. of UV radiation causes 90% bactericidal action while the comparable threshold dose of 12,700 rep of gamma radiation causes only 40% bactericidal action. It was therefore concluded that at the same level of off-flavor production, ionizing radiations at low levels are much less effective than ultraviolet radiation in the destruction of bacteria in raw whole milk.

The apparent superior bactericidal effectiveness of ultraviolet radiation was, however, found to disappear when doses of both ionizing and non-ionizing radiations were increased to levels required for the sterilization of milk.

This observation is illustrated in Figure 5 in which the severity of off-flavors (expressed as hedonic ratings) produced by both radiations tends toward the same degree of intensity as the irradiation dose increases. It is further illustrated by a comparison of Figures 1 and 2 in which flavor difference threshold concentrations (a good index of flavor intensity) has been plotted as a function of irradiation dose for each type of irradiation. Both curves may be considered essentially identical except that ultraviolet induced off-flavor in milk is first noticed at higher doses than in the case of ionizing radiations. This advantage disappeared, as noted above, as irradiation doses increased since in both cases the same flavor difference threshold concentration was reached.

It has been concluded on the basis of this work that the intensity of off-flavors produced by ultraviolet radiation, gamma rays, and cathode rays is the same at the radiation levels required to successfully destroy the microorganisms present in raw whole milk.

Acknowledgment

The authors are appreciative of financial assistance in the form of grants-in-aid from the following organizations which made a part of this program possible: Armour and Company, Carnation Company, The Nestlé Company and Oscar Mayer and Company.

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Comparative Evaluation of Various Small Capacity Commercial Potato Peelers[a]

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(Manuscript received May 31, 1958)

SMALL, PORTABLE, abrasive-type potato peeling machines were tested by the Food Science and Engineering Division of the U. S. Naval Supply Research and Development Facility to determine their peeling characteristics and the feasibility of using such machines aboard submarines and small ship galleys where potatoes are presently peeled by hand. Heretofore, the sole criteria for judging the performance of mechanical potato peelers have been, first, speed of peeling and second, machine peel losses. Prior investigations, applicable military specifications *(1, 5, 6, 7)*, and pertinent literature *(1, 2, 3, 8)* have failed to note the significance of hand eying and hand finishing losses as part of the complete peeling operation, or to correlate hand eying and finishing losses with machine peel losses.

Since potatoes are peeled until most of the outer skin has been removed by normal machine-peeling operations, with the remaining skin and eye removed by hand, peel losses investigated in this study included both machine peel losses and hand eying and finishing losses. Speed of peeling has been variously specified *(1, 5, 6, 7)* as either 1¼ min. or 3 min., depending upon the construction of the machine.

Test procedures were devised to investigate the machine peel losses, the hand eying and finishing losses, the speed of machine peeling, and the overall time of the complete machine-peeling operation.

EXPERIMENTAL METHODS

Potato peeling machines tested. Five commercial potato peeling machines were loaned by cooperating manufacturers[b] for this evaluation (Figure 1). These machines are small, portable, electrically-operated batch-type abrasive peelers. Permanent utility connections are not required as the machines can be operated on a sink drainboard and supplied with water from the nearest water tap through a flexible hose and with electricity by means of a plug-in line cord. The machines are hereinafter designated as Machines A through E.

Definition of terms. Machine potato peeling in ordinary operations is limited to removing the skin only. This has been defined *(6)* as "Potatoes shall be considered satisfactorily peeled when practically all of the outer and under skins, except for the eyes, shall be removed as shown. . . . " Figure 2 shows potatoes before and after machine-peeling, in accordance with the definition. Since the remaining skin and eyes are removed by hand, the peel losses incurred in machine tests were considered to be 2 separate losses—machine peel losses and hand finishing peel losses—with the total of these 2 losses defined as the "total peel loss." "Machine peel loss" is defined as the loss in weight incurred by peeling in the machine. "Hand finishing loss" is defined as the loss in weight incurred in hand finishing and eying the potatoes after being peeled in the machine.

[a] Presented at the Eighteenth Annual Meeting of the Institute of Food Technologists, Chicago, May 28, 1958.

[b] The Department of the Navy does not permit disclosure of the manufacturer's names.

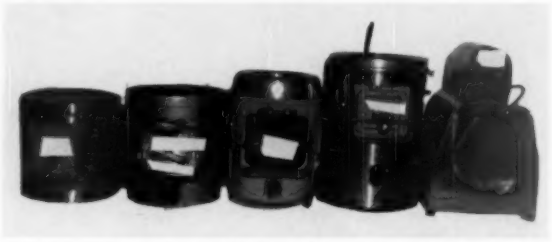


Figure 1. Small, portable, electrically-operated batch-type abrasive potato peeling machines of the type tested.

Machine peeling test procedures—laboratory method. To establish a basis of comparison and to standardize methods of testing, procedures used in testing each machine were:

1. 50 lbs. of raw, unpeeled potatoes were weighed and placed in a tub of water at 70° F.[c]

2. After 1 min., a 10-lb. batch load was machine peeled for 1 min. and weighed wet as it exited from the machine.

3. This machine-peeled batch was then hand eyed and finished.[d] Each potato was placed in a weighed tub of water as it was finished. Total weight and the time to hand finish were recorded upon completion of the batch.

4. Each succeeding 10-lb. batch was machine peeled as in Step 2 and hand finished as in Step 3.

5. Machine peel losses were computed from data obtained in Step 2. Hand finishing peel losses were computed from data obtained in Steps 2 and 3.

Procedures outlined in Steps 1 through 5 were repeated, with time increments of ½ min. to 5 min.[e]

To determine the effect of load on the performances of the machines, the procedures outlined above were again repeated using a batch load weight of 15 lbs.[f]

Machine peeling test procedures—Navy method. Since satisfactory peeling in normal operations is left to the operator's judgment, tests were conducted to determine the peeling time and losses resulting from this type of operation. Two Navy

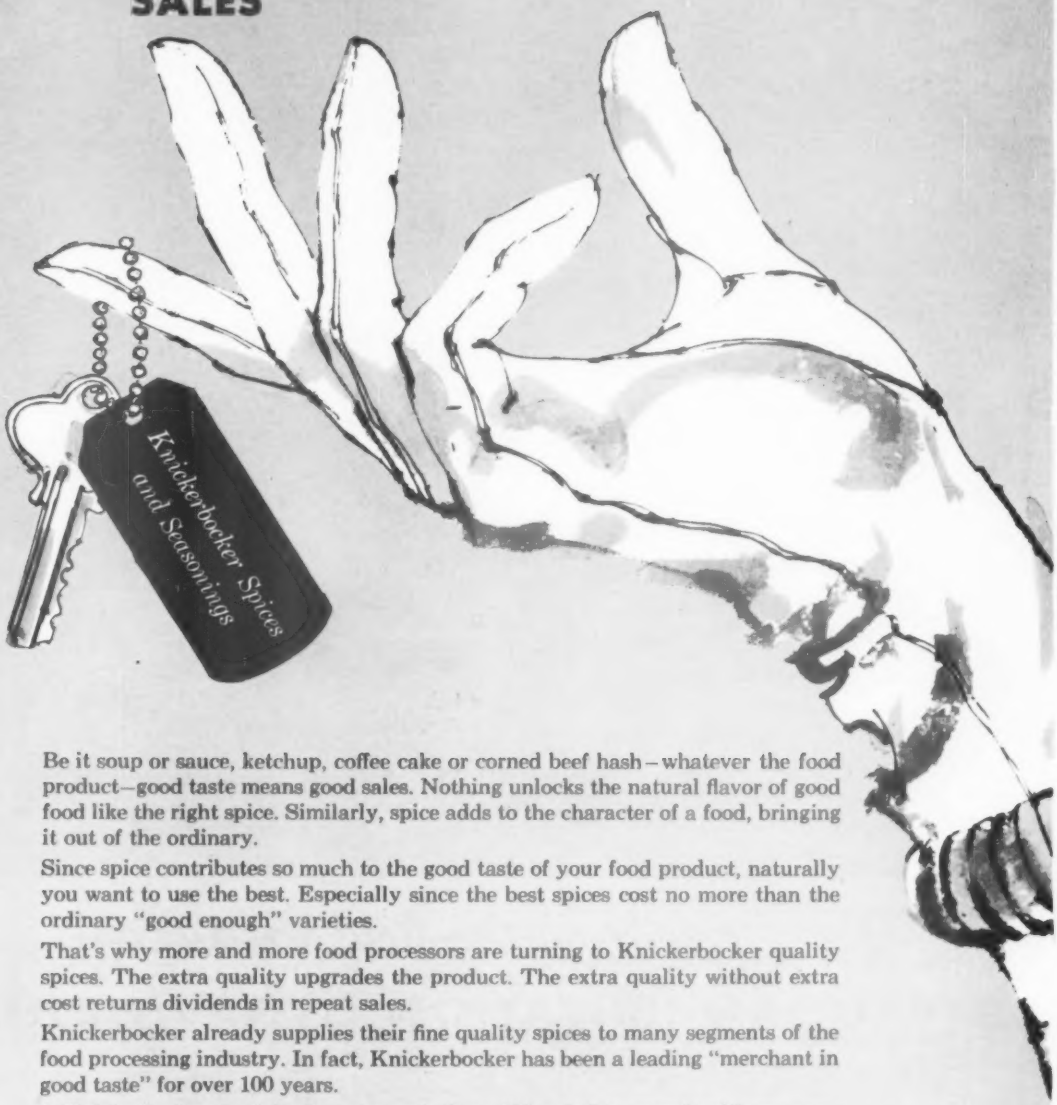
[c] This step was included to duplicate procedures of ordinary hand methods of peeling and to overcome the factor of introducing dry potatoes into the machine and having them exit wet due to the water flow in the machine. Instances were noted where wet, peeled potatoes weighed more than the dry, unpeeled potatoes fed into the machine.

[d] Hand finishing was performed by 2 men using two "Nee Action" hand tools.

[e] Satisfactory peeling is ordinarily left to the judgment of the operator. The time of satisfactory peeling, however, is limited in Military Specification MIL-V-2826 to 1 min., 15 seconds for machines having abrasive-coated walls. In Federal Specification OO-V-185, the peeling time is specified as 1 min., 15 seconds for machines having one type of abrasive-lined walls, 3 min. for machines having another type of abrasive-lined walls, and 3 min. for machines having unlined cylinder walls. The manufacturers, in general, recommended that potatoes be peeled in 1 min.

[f] Use of 10 and 15-lb. batch loads applies to all but Machine E. This machine, because of its slightly larger size and the manufacturer's larger capacity rating, was tested using 15 and 20-lb. batch loads.

GOOD TASTE IS THE KEY TO REPEAT SALES



Be it soup or sauce, ketchup, coffee cake or corned beef hash – whatever the food product – good taste means good sales. Nothing unlocks the natural flavor of good food like the right spice. Similarly, spice adds to the character of a food, bringing it out of the ordinary.

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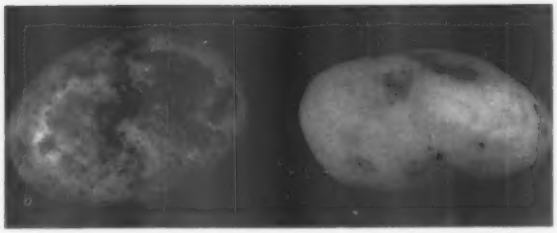

Figure 2. Unpeeled potato is shown on left; potato shown on the right is considered satisfactorily peeled by machine. Hand finishing is required to remove eyes and peel in the depressions near the eyes.

cooks separately peeled potatoes in each machine until satisfactorily peeled according to their judgments. Peeling losses and times were determined as above.

RESULTS

Laboratory method. Peel losses for each machine at each batch load weight tested were plotted graphically as shown in the typical curve in Figure 3. The difference in the slopes or rate of increase of the machine peel loss curves indicates that some machines peel faster or remove the outer potato surfaces faster than others. This is further indicated by the fact that for any given per cent machine peel loss, the peeling time varies from machine to machine.

Generally, it was found that the machines which attained any given per cent machine peel loss faster also incurred a larger total peel loss with a larger hand finishing peel loss. Where the machine performance was the same (the same per cent machine peel loss at the same machine peeling time), differences in both the percentage of hand finishing peel loss and total peel loss were still found to exist, although this difference was generally smaller than the differences between the faster and slower machines. These characteristics can best be seen from the graphs shown in Figures 4, 5 and 6. The difference between

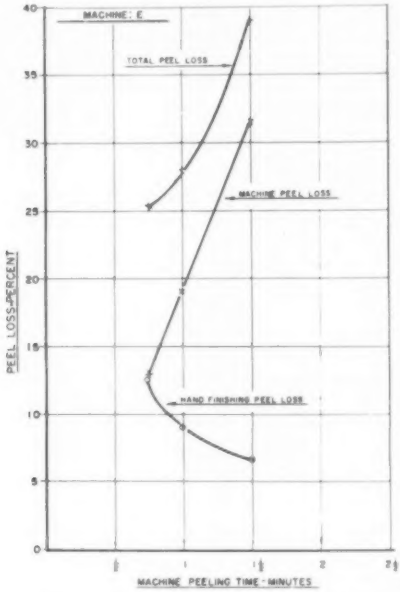

Figure 3. Typical peel loss curve for portable, batch-type, counter model potato peelers.

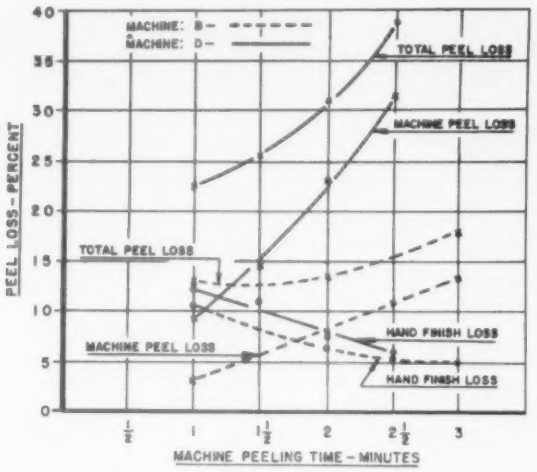

Figure 4. Peel loss curve for machines "B" and "D" potato peelers (load wt. 10 lbs.).

a "fast" and a "slow"[5] machine is illustrated in Figure 4, where for any given machine peeling time, the "fast" machine (Machine D) has a higher per cent machine peel loss than the "slow" machine (Machine B), as well as a higher total peel loss.

The difference between 2 machines having the same per cent machine peel loss for the same machine peeling time is illustrated in Figure 5, where the total peel loss for Machine D is higher than the total peel loss for Machine C as a result of higher hand finishing peel losses. Differences between the total peel losses exhibited in Figure 5 can be seen to be less than the differences exhibited in Figure 4. As in the case with 2 different machines, it was found that Machine E, when used to peel 2 different batch weights, had the same machine peel loss for the same machine peeling time with each weight peeled, but the total peel loss was appreciably different (Figure 6).

Navy method. Results of the performance tests for machine peeling by Navy operators are shown in Table 1. The machines which required the longer time to reach the point of satisfactory peel yielded lower losses than the "faster"

[5] The term "fast" applied to a machine is intended to mean that this machine peels a similar batch of potatoes in less time than a "slow" machine.

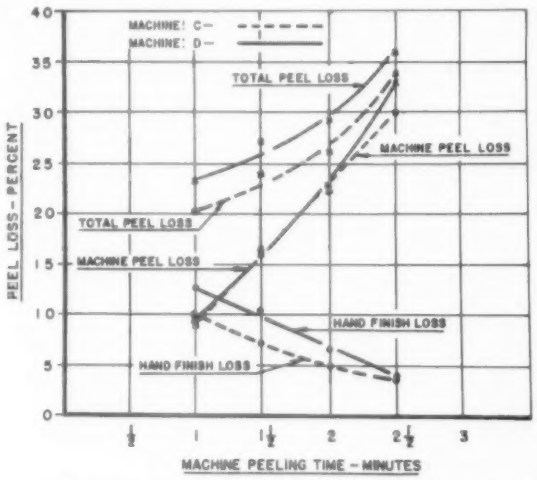

Figure 5. Peel loss curve for machines "C" and "D" potato peelers (load wt. 15 lbs.).

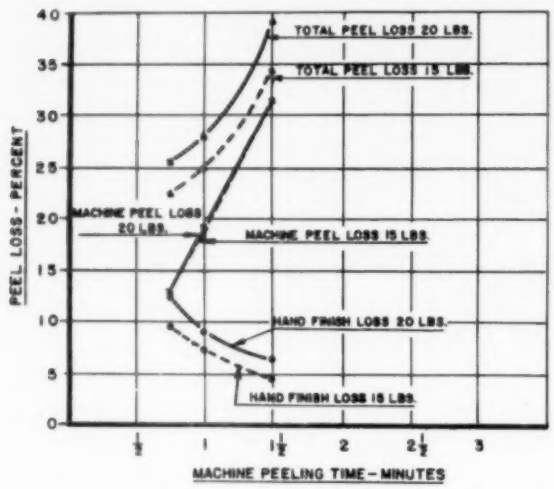

Figure 6. Peel loss curve for machine "E" potato peeler (load wt. 15 and 20 lbs.).

machines. When peeling the larger batch loads, the machine peeling time required to reach the point of satisfactory peel increased slightly in each machine, except for Machine A which decreased slightly. The peeling losses resulting when the larger batch loads were peeled increased slightly in each machine over the losses for smaller loads. In the "slower" machines, the machine peel loss increase was only slight; the hand finishing peel loss and total peel loss increased more appreciably.

The time required to hand finish the machine peeled potatoes correlated closely with the hand finishing peel losses. The machine peeled potatoes having the lower hand finish loss required less time to hand finish than those having larger hand finishing losses (Table 1). Lower hand finishing times, as well as lower hand finishing losses, were characteristic of the "slow" machines.

General results. The speed of rotation of the abrasive-coated discs appeared to have little direct relationship between the speed of machine peeling or the peel losses. In Machine B, a "slow" machine with comparatively low losses, the speed of the rotating disc was measured at 320 r.p.m. during peeling tests with 15 lbs. of potatoes, whereas the speeds of the discs in the "fast" machines with comparatively high losses were measured at 320 r.p.m. for Machine C, 340 r.p.m. for Machine D, and 440 r.p.m. for Machine E under similar load conditions. The size of the grit in the abrasive-coated surfaces appeared to have considerable bearing on the peel losses. The method of distribution of the weight of the load appeared to have an additional bearing on losses.

Examination and comparison of the individual curves showed that the peel loss curves of the "slow" Machines A and B are appreciably lower than those of the "fast" Machines C, D and E. The lower curves indicate that peel losses were considerably lower in the "slow" machines throughout their entire peeling range. Further evidence of the lower peel losses in the "slow" machines is shown in Table 1. At their observed point of satisfactory peeling, the 2 "slow" machines had total peel losses of 15.7% and 16.6% as compared to 24.8%, 26.1%, and 27.0% total peel losses at the comparable observed times of satisfactory peeling in the "fast" machines.

Although less time was consumed in the machine peeling step in the 3 "fast" machines, the overall time of machine peeling and hand finishing was found greater in the 3 "fast" machines than in the 2 "slow" machines. As shown in Table 1, the time required to machine peel and hand finish 15 lbs. of potatoes in the "slow" Machine A was approximately 13.4 min. (3.4 min. machine peeling time plus approximately 10 min. hand finishing time) and approximately 14.8 min. in the "slow" Machine B. In the "fast" Machines C, D and E, the total times to completely peel 15 lbs. of potatoes were approximately 15.7 min., 16.7 min., and 17.0 min., respectively. It can be seen, therefore, that in the type of operation studied, time cannot be saved in the over-all operation by using a "fast" machine.

DISCUSSION

Any valid decision regarding the relative performance of the various machines must be based on the consideration of the function or functions deemed most important. Which machine does the most efficient job of peeling? To resolve this question, a decision must first be made as to whether the user wants efficiency based upon time, disregarding food losses, or efficiency based upon finished product yield, with time of secondary concern. For naval use, because of critical storage space problems, finished product yield is the major concern. A significant difference in time might preclude a choice on the basis of yield, but examination of Table 1 shows that for the tests conducted under probable Navy operating conditions, the maximum time difference was 3.6 min. for a 15-lb. batch. Since time is, for all practical Navy purposes, irrelevant, a common denominator is needed to compare the peeling efficiency. In terms of the yield, therefore, the machine with the least peel loss would be the most efficient.

In the past, yield has been limited to a comparison based on machine peel loss alone. The unreliability of using machine peel loss alone as the indicator of efficiency can be seen in Figure 7, which shows samples taken from different batches of potatoes, each batch having been peeled to give the same machine yield in 2 different machines. The machine peel loss in each

TABLE 1

Performance of small, portable, electric potato peelers in Navy peeling operations

Batch load	Machine	Average machine peeling time at the observed point of satisfactory peeling	Average time to hand finish	Approximate total time to peel	Per cent peel losses		
					Machine	Hand finish	Total
(lbs.)		*(min.)*	*(min.)*	*(min.)*			
10	A	3.6	8	11.6	10.5	3.5	14.0
	B	2.3	9	11.3	10.7	4.3	15.0
	C	1.5	12	13.5	15.0	9.5	24.5
	D	1.5	11	12.5	15.2	10.4	25.6
15	A	3.4	10	13.4	10.6	5.1	15.7
	B	2.8	12	14.8	10.8	5.8	16.6
	C	1.7	14	15.7	16.5	8.3	24.8
	D	1.0	16	17.0	18.6	7.5	26.1
	E	1.7	15	16.7	16.5	10.5	27.0
20	E	1.0	16	17.0	18.6	7.5	26.1

Figure 7. Potatoes peeled in two different machines, each machine resulting in 10% machine peel losses. Potatoes peeled in Machine A are shown on the left; Machine D on the right. It can be seen that the potatoes on the left require less hand finishing than those on the right.

batch was 10%. Potatoes peeled in Machine D have more skin and eye remaining to be removed by hand than those from Machine A. How much more efficient a job was done by Machine A can be measured by the difference between the hand finishing peel losses incurred in each machine. The curves in Figures 5 and 6 show additional cases where differences in hand finishing peel losses resulted even though the performances of the machines were the same with respect to machine peel losses.

From an efficiency of yield standpoint, therefore, the most efficient machine is that which yields the least hand finishing peel loss for any given machine peel loss. To reflect the efficiency of the *overall* peeling operation, we can say, then, that *the most efficient machine is that which yields the least total peel loss at a given machine peel loss.*

Total peel losses. The basic premise in this study was that peel losses incurred in operations actually consisted of: (1) machine peel losses, and (2) hand finishing peel losses. For convenience, the sum of these 2 losses was expressed as "total losses." The importance of this premise can be seen by an analysis and study of several of the test results.

In Figures 5 and 6, examples are shown in which the machine peel losses are almost identical. In both instances, therefore, it follows that the potato skins were abraded at almost identical time-loss rates. In each instance, however, the hand finishing losses of one machine (or one load weight) were appreciably lower than those of the other. Since the "total" loss is the sum of both machine peel and hand finishing losses, this difference is reflected in the lower "total" loss curve in the machine (and load weight) having the lower hand finishing peel loss. Whatever the causes, one machine in each instance clearly had less actual losses, despite an obvious similarity in machine peel losses. This indicates a latent difference in machine peeling action which can be made apparent only by investigating the hand finishing peel losses as well as the machine peel losses.

It is obvious, that any judgment, evaluation, or comparison of the performance of potato peelers of the type tested, based on machine peel losses alone, as has previously been customary, is inadequate and unrealistic.

Total peel losses, since they summarize the actual peel losses incurred and reflect the manner in which they are incurred, are considered to be an accurate and comprehensive measure of the peel losses incurred in machine potato peeling operations.

Design features of efficient peelers. A study of the construction of all 5 machines indicated that the lower peel losses in Machines A and B could be attributed to certain of their design and structural features. In these machines, the abrasive surfaces were noticeably different from the others. The particle size of the gritty abrasive material was smaller, their abrasive surfaces relatively smoother. Since peeling in abrasive-type potato peelers is accomplished by the abrading action on the potatoes being tumbled by the abrasive-coated rotating disc (and the cylinder walls where they are abrasive-coated), the type of surface materially affects the peel losses. The smaller grit size and the smoother abrasive surface in these 2 machines resulted in less usable potato being abraded along with the potato skin.

Figure 7 illustrates the effect of grit size and abrasive surface on potato peeling. Machine A, with smaller grit size and smoother surface, peeled potatoes with considerably lower losses than Machine D. In Machine A, the reasons for lower peel losses were readily apparent. This machine is entirely different from the other four in that it is made up of a number of small, vertical, abrasive-coated buffer wheels arranged on 3 horizontal axes rather than a single, abrasive-coated, horizontal rotating disc. In addition to its small grit-sized abrasive surfaces, the lower peel losses in this machine can be attributed to two assignable effects of its construction and operating principle. First, the narrow, individual buffer wheels caused more peeling action into the eyes and along the natural contours of the potato. Second, the horizontal grouping of the vertical buffer wheels served to spread the weight of the potatoes and reduce the pressure at the points of contact with the abrasive surfaces. Less pressure at the point of contact resulted in less usable potato being abraded along with the skin. The importance of this type peeling action can be seen in Figure 8.

Greater peeling action along the natural potato contour results not only in lower machine peel losses, but lower hand finishing losses as well. It can readily be seen from Figure 8 that more peeling action into the deep eye would leave less skin to be removed by hand. The effect of this peeling action on machine peel losses is of equal importance. In an ordinary disc-type potato peeler, a large portion of the "high" spots near the eyes must be abraded before any peeling action is possible in the eye. Where machine peeling action follows the natural contours of the potato, less of the usable "high" spots are abraded before peeling takes place in the eye. The overall effect, therefore, is less

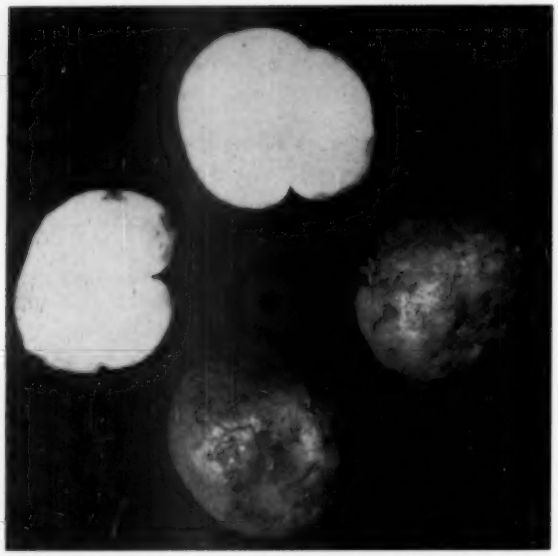

Figure 8. Unpeeled potatoes and cross sections of the same potatoes showing deep eyes and natural potato contour.

machine peel loss because of less abrasion of the high spots, and less hand finishing loss because of greater peeling action along the contour and into the eyes. Figure 7 shows these effects.

SUMMARY

Five small portable, abrasive-type mechanical potato peeling machines were evaluated by determining their peeling characteristics as revealed by their machine peel losses, their hand finishing peel losses, the speed of machine peeling, and the overall time of machine peeling and hand finishing. It was found that mechanical potato peelers may appear to be similar in their machine peeling actions, yet differ appreciably in their hand finishing losses.

Presently used criteria of judging abrasive-type machine potato peelers on the basis of machine peel losses alone were found to be unsatisfactory. Total peel losses, the sum of the machine peel losses, and the hand finishing peel losses are a more accurate and comprehensive measure of the actual peel losses incurred in machine peeling operations.

Machines which abraded the potato skins at a slower rate were generally more efficient than the more rapid. The differences in the time consumed for the overall peeling operation were not found to be appreciable between the "fast" and "slow" machines. The machine having the smaller grit size and smoother abrasive surfaces, which followed the natural potato contour in peeling, produced lower peel losses.

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Degradation of Chlorophyll to Pheophytin During Sterilization of Canned Green Peas by Heat*

(Manuscript received June 20, 1958)

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University of Wisconsin, Madison

CANNED GREEN VEGETABLES undergo a marked change from bright green to olive-brown color when sterilized by heat. Campbell *(6, 7)* and Mackinney and Weast *(18)* studied a similar change in color during storage of frozen peas. They found it was due to the substitution of the magnesium of the chlorophyll molecule by hydrogen supplied from plant acids, forming the pigment, pheophytin. The same reaction was found by Dutton, Bailey and Kohake *(11)* to occur during the dehydration of spinach, and may be considered a major cause of color change during dehydration of green vegetables in general.

Mackinney and Weast *(18)* suggested that owing to the severe conditions employed in heat processing, it is probable other degradation products besides pheophytin occur. Westcott *et al. (26)* found pheophytin and small amounts of pheophorbide, an acid hydrolysis product of pheophytin, in commercially canned green bean puree. Siegele *(21)*, however, in a study of the chlorophyll derived pigments in canned green beans, found only pheophytin. In these experiments, the heat treatments given the canned beans during sterilization were sufficient to cause the complete conversion of chlorophyll to pheophytin, whether at 240° F. for 20 minutes or 260° F. for 4 minutes.

Mackinney and Joslyn *(15, 16, 17)* sought to define the kinetics of the conversion of chlorophyll to pheophytin. They used solutions of chlorophyll in aqueous acetone containing various amounts of acid. The reaction rate was determined at several temperatures between 0 and 51° C. (32 and 123.8° F.). Their results indicated that the reaction was first order with respect to both acid and chlorophyll. The rate of reaction of chlorophyll *a* was 7 to 9 times that of chlorophyll *b*.

A number of methods have been developed to inhibit the degradation of chlorophyll in canned green vegetables during heat sterilization by reducing the concentration of acid in the tissue *(2, 13, 20, 25)*. The best known of these methods is the process developed and patented by Blair *(3, 4, 5, 8)*. The Blair process, however, has not been extensively adopted, nor is the color completely protected by it.

At the present time, little information is available concerning the kinetics of the degradation of chlorophyll under the conditions necessary for the sterilization of canned green vegetables. Therefore the present study was undertaken to determine the rate of the degradation reaction under various processing conditions. It was also desired to determine the quantitative relation between the extent of conversion of chlorophyll to pheophytin and the degree of color change.

* The project was supported in part by the Research Committee of the Graduate School with funds provided by the Wisconsin Alumni Research Foundation.

EXPERIMENTAL METHODS

The study was conducted over a period of 2 years, 1956 and 1957. During the first year, canned peas were heat processed for various lengths of time under conditions similar to those employed commercially. During the second year, the heating and cooling lags inherent in commercial retort operation were minimized by the use of a special apparatus similar to the one described by Schmidt, Bock and Moberg *(19)* and illustrated in Figure 1. Also, during the second year, the rate of the reaction was studied in pea purees in which the acid concentrations were adjusted by the addition of various amounts of acid or base.

During the first year peas were obtained from commercial canneries without regard to variety, maturity or other variable quality characteristics. The peas were cleaned, washed and blanched in pilot plant equipment. The blanching conditions used were: (a) none; (b) 160° F. for 3 minutes; and (c) 190° F. for 3 minutes. The peas were blanched by immersion in water and then cooled in flowing tap water. They were then packed in 300 x 411 plain tin cans, covered with boiling 2% sodium chloride solution, and closed at atmospheric pressure. The unblanched peas were packed into 211 x 413 plain tin cans, covered with cold salt solution, and closed under about 15 inches of vacuum.

The blanched and unblanched peas were heat processed in a laboratory retort as follows:

212° F. (100° C.) for 30, 90, 150 and 210 minutes;
240° F. (115.6° C.) for 5, 15, 25 and 35 minutes; and
260° F. (126.7° C.) for −3 (3 minutes before retort atmosphere reached 260° F.), 4.5, 8.5 and 11.5 minutes.

The cans of peas processed at 212° F. were heated in boiling water, and the others in steam. The process intervals listed above were measured from the time that the retort atmosphere reached processing temperature, which took between 6 and 8 minutes. An additional 2 to 4 minutes were required for the centers of the cans to reach the temperature of the retort atmosphere. The cans of processed peas were cooled in flowing tap water. Those to be used for determining the rate of degradation of chlorophyll were punctured, and the brine was drained from them. The punctures were sealed with freezer tape, and the cans were stored at −15° F. for subsequent analysis.

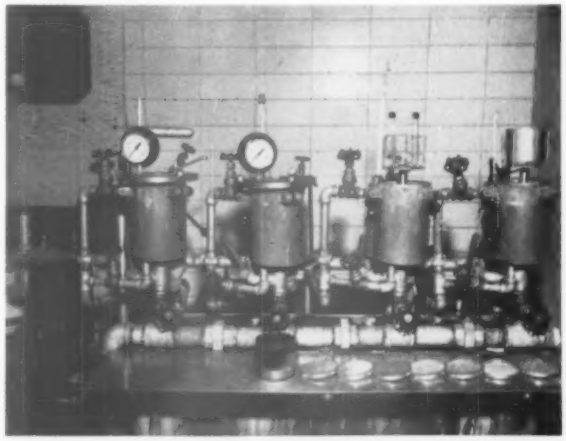

Figure 1. Experimental thermal process apparatus illustrating the method for containing peas and tubes of puree.

A study was made of the effect of time and temperature of storage on the retention of the pigment in the canned sterilized peas. Cans of peas were stored at 40° F. and at room temperature in the laboratory (about 75° F.). Sample cans were withdrawn after various periods of storage up to 2 months. The brine was drained as previously described and the peas were kept at −15° F. for subsequent analysis. Each experiment was replicated twice.

The following analyses of the processed frozen peas were performed: degree of conversion of chlorophyll to pheophytin; pH determination; titratable acidity; moisture content; and color measurement. The methods used were as follows:

Degradation of chlorophyll was measured by the method of Dietrich *et al. (10)*. The optical densities of the acetone extracts were measured in 5 cm. cells with a Beckman DK-2 Ratio Recording Spectrophometer. Sensitivity of the instrument was adjusted to give a slit width of 0.015 mm. at 550 mμ. The pH was determined using a 10-g. sample of peas, after blending for 3 minutes with 20 ml. of carbon dioxide-free water in an Osterizer blender. Titratable acidity was determined by titrating the slurry to pH 8.3 with 0.1N NaOH. Moisture content was measured using a 10-g. sample of peas, which was ground with a mortar and pestle and then dried for 2 hours at 125° C., cooled in a dessicator and weighed. The results of this method agreed well with the results of the vacuum method cited by the Association of Official Agricultural Chemists *(1)*. Color of the processed peas was measured with a Hunter Color and Color Difference Meter, using a Munsell color standard 5 GY 6/8 with the following Hunter values: L = 55.06; a_L = −17.80; b_L = 27.15. The peas were packed into a 6 cm. diameter glass cell and covered with distilled water to minimize light diffraction at the surfaces.

During the second year (1957) some modifications were made in the general procedure. Because chlorophyll is sensitive to light *(22, 28)*, the analytical work was performed in a laboratory darkened to a light intensity of less than one foot candle.

Fresh washed and inspected peas of the Perfection variety, size 3, were obtained each morning from a commercial cannery. The peas were transported to the laboratory and held until used, in crushed ice.

The peas were heat processed either without a blanching treatment or after being blanched in boiling water for 2 minutes. Heat processing was accomplished with the special retorts. Single layers of peas were placed in 4¼ inch diameter baskets, the bottoms of which were made of 12-mesh stainless steel screen; the sides were ⅝ inch high and of sheet stainless steel. Seven baskets were placed inside a larger basket, 4⅝ inches in diameter, also with a bottom made of 12 mesh stainless steel screen, and a wall, 4 inches high, made of sheet stainless steel. The larger basket, containing the seven small baskets, was held in place in the retort by a special brass holder, shown in Figure 2. The peas were thus heated by direct contact with steam and cooled by direct contact with water.

The temperature at the center of a pea was measured by means of a thermocouple consisting of copper and constantan wires, 0.005 inch diameter. One of the wires was threaded through a pea with a no. 14 bead needle. The ends of the 2 wires were twisted tightly and welded together electrically, using a mercury bath as one electrode and the thermocouple as the other. The welded end was then carefully untwisted so that the weld was the only point of contact and the pea was slipped over it. The temperature of the atmosphere in the retort reached the desired level in 10 to 15 seconds after application of steam. An additional period of 30 to 55 seconds was required for the centers of the peas to reach the temperature of the retort atmosphere. The following times and temperatures were used to heat process the blanched and unblanched peas in the special retorts:

240° F. (115.6° C.) for 1, 5, 10, 15, 20, 25, 30 and 35 minutes;
260° F. (126.7° C.) for 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0 and 8.0 minutes;
280° F. (137.8° C.) for 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5 and 5.0 minutes.

The intervals were measured from the time that the retort atmosphere reached the desired temperature. At termination of the heat process intervals, the peas were cooled by circulating cooling water through the retorts. Constant pressure was maintained in the retort in the initial stages of the cooling cycle by admitting compressed air.

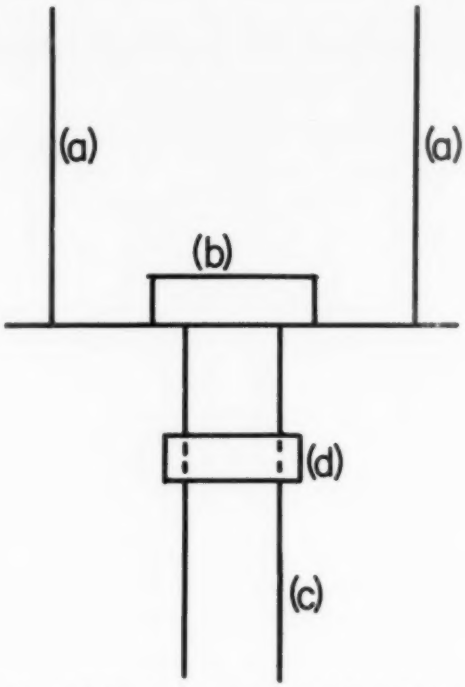

Figure 2. Holder for baskets and test-tube racks in experimental retort.

(a) brass rod fingers—hold basket in place
(b) perforated plate to baffle steam
(c) stem—fits into steam inlet pipe
(d) collar—rests on top of steam inlet pipe, keeping the holder at the desired height.

Aliquots were taken from the processed and cooled peas for the determination, immediately, of pH and for color measurement. In addition, titratable acidity and moisture content were determined for zero-time samples (which received no heat process). The remainder of the peas were placed in pint-size polyethylene bags. The bags of peas were flushed with nitrogen, heat sealed and frozen in a dry ice-acetone bath. The peas were then stored at −15° F. for subsequent analysis of chlorophyll. All analytical procedures were the same as those previously described.

The statistical design used for these experiments consisted of a split-plot on a randomized block. Processing temperatures (240, 260 and 280° F.) were the whole plots and blanching conditions (blanched or not blanched) were the sub-plots. Each experiment was replicated twice.

The effect of acidity upon the rate of degradation of chlorophyll was studied by the incorporation of various amounts of acid or base into pea purees. One hundred and fifty grams of blanched peas were blended in an Osterizer blender for 3 minutes with the proper amount of acid or base and sufficient glass distilled water to make a liquid volume of 150 ml. A power of 80 volts was used for blending, since the use of higher speeds caused undesirable foaming. The mixture was flushed with nitrogen for 5 minutes prior to and during blending to minimize the oxygen tension in the puree. The following amounts of acid and base were used: a) 20 ml. 0.1N HCl; b) no added acid or base; c) 20 ml. 0.1N NaOH; or d) 40 ml. 0.1N NaOH. The purees were placed in 16 x 160 mm. pyrex culture tubes and closed with thermostabile plastic screw caps. The following times and temperatures were used to process the tubes of puree in the special retort apparatus:

240° F. (115.6° C.) for 1, 5, 10, 15, 25, and 35 minutes:

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260° F. (126.7° C.) for 0.5, 1.0, 2.0, 3.0, 5.0 and 7.0 minutes;
280° F. (137.8° C.) for 0.5, 1.0, 1.5, 2.0, 3.0, and 5.0 minutes.

Approximately 2 minutes were required for the centers of the tubes of puree to reach the temperature of the retort atmosphere. Determination of pH and analysis of chlorophyll were made of the heat processed and non-processed purees. The pH was determined using a 10-g. sample of puree, diluted with 10 ml. of carbon dioxide-free water. The chlorophyll analysis was performed as follows: 20 g. of puree were blended with 30 ml. acetone for 3 minutes. Thirty ml. of acetone were added and the mixture was stirred for 3 minutes. The mixture was filtered through a coarse sintered glass filter with mild suction and the filtrate was diluted to 100 ml. with acetone. The final solution was filtered again without suction through Whatman no. 42 paper. The spectrum of the solution was measured and the per cent conversion of chlorophyll to pheophytin was determined in the manner used for whole peas. In addition to the above analyses, titratable acidity and moisture content of the samples of puree which received no heat process were determined. All analyses were performed immediately following heat processing. The statistical design used for the experiments with purees consisted of a 4 x 3 factorial randomized complete block. Each experiment was replicated twice.

To determine the usefulness of an inexpensive colorimeter to estimate the degree of conversion of chlorophyll to pheophytin, the ratio, $O.D._{550}/O.D._{558}$ was determined for 90 acetone extracts of purees, using a Bausch and Lomb Spectronic 20 Colorimeter. The ratio was designated R'.

All analyses of variance and calculations of correlations were performed according to the methods described by Snedecor *(23)*. The slopes of lines drawn in the calculation of kinetic constants were calculated according to the methods given by Snedecor for the determination of b, the slope of a regression line.

RESULTS

A straight line relationship was found to exist between the logarithm of the per cent of unchanged chlorophyll and the time of heat processing at a given temperature. This indicates pseudo-first-order kinetics *(9, 12)*. The pseudo-first-order rate constants are listed in Tables 1, 2, and 3.

The logarithms of the first-order rate constants found in peas examined in 1957 were plotted against 1/T (T in deg. K.). The slope of the line multiplied by 2.303R (R = 1.987 cal.) to arrive at the apparent activation energy. Values of 16.1 Kcal. and 12.6 Kcal. were found for blanched and unblanched peas, respectively. Insufficient data were obtained in 1956 to enable precise calculation of kinetic constants. However, when these data were submitted to the same analysis given the 1957 data, the apparent activation energies of 15.6 and 16.9 Kcal. were calculated for blanched and unblanched peas, respectively.

The pseudo-first-order rate constants for the reaction in the pea purees varied linearly with the initial (before heat processing) titratable acidity of the purees. The slopes of these lines are listed in Table 4. These slopes were related linearly to temperature. The slope of the line relating these two variables was 0.012 (degree C.)$^{-1}$.

A marked decrease in titratable acidity occurred during blanching, as shown in Table 5. It was found that this decrease was due to the loss of soluble acids in the blanch water.

A high linear correlation was found between the value, $-(a_L/b_L)$[b], determined for peas with the Hunter Color and Color Difference Meter, and degree of conversion of chlorophyll to pheophytin. The correlation coefficient, r, was −0.922 and was highly significant. The number of observations was 174. The equation of the regression line is:

$$-(a_L/b_L) = 0.931 - 0.00747 \text{ (per cent loss of chlorophyll)}$$

The regression line and the confidence interval at the 0.01 level of probability is shown in Figure 3.

[b] Hue of the color.

TABLE 1

Pseudo-first-order rate constants, in minutes^{-1}, for conversion of chlorophyll to pheophytin in blanched and unblanched peas given various heat process temperature treatments (1957)

Heat process temperature	Blanching treatment			
	Blanched		Not blanched	
	Replicate		Replicate	
	No. 1	No. 2	No. 1	No. 2
115.6 deg. C.	0.124	.....*	0.115	.....*
126.7 deg. C.	0.206	0.232	0.199	0.217
137.8 deg. C.	0.378	0.386	0.322	0.302

* Data not sufficiently definitive for calculation of rate constant.

TABLE 2

Approximate pseudo-first-order rate constants, in minutes^{-1}, for conversion of chlorophyll to pheophytin in peas blanched by different methods and heat processed at various tempera*ures (1956)

Blanching treatment	Heat process temperature		
	100 deg. C.	115.6 deg. C.	126.7 deg. C.
None	0.0442	0.109	.....*
160 degrees F.	0.0455	0.147	.....*
190 degrees F.	0.0663	0.096	.....*

* Insufficient data available for calculation of rate constant.

TABLE 3

Pseudo-first-order rate constants in minutes^{-1}, for conversion of chlorophyll to pheophytin in pea purees, adjusted to various acidities, and heat processed at various temperatures

Heat process temperature	Amount of acid or base included in 300 grams pea puree mixture			
	20 ml. 0.1N HCl	none	20 ml. 0.1N NaOH	40 ml. 0.1N NaOH
115.6 deg. C. (240 deg. F.)				
Replicate No. 1	.....*	.....*	0.0866	0.0755
Replicate No. 2	0.261	0.119	0.0762	0.0539
126.7 deg. C. (260 deg. F.)				
Replicate No. 1	.....*	.....*	0.117	0.0409
Replicate No. 2	0.491	0.241	0.097	0.0673
137.8 deg. C. (280 deg. F.)				
Replicate No. 1	.....*	.....*	0.414	0.147
Replicate No. 2	0.839	0.477	.....*	0.095

* Data not sufficiently definitive to enable calculation of rate constant.

TABLE 4

Slope of the lines relating the pseudo-first-order rate constants for the conversion of chlorophyll to pheophytin in pea purees processed at various temperatures, to their titratable acidities expressed as milliequivalents per 10 grams dry solids

Temperature	Slope
240 deg. F. (115.6° C.)	0.197
260 deg. F. (126.7° C.)	0.237
280 deg. F. (137.8° C.)	0.374

TABLE 5

Titratable acidity (expressed in milliequivalents of acid per 10 grams of dry solids) of peas given different blanching treatments before being heat processed at different temperatures (1957)

Heat process temperature	Blanching treatment			
	Blanched		Not blanched	
	Replicate		Replicate	
	No. 1	No. 2	No. 1	No. 2
240 deg. F. (115.6 deg. C.)	0.74	1.06	1.43	1.61
260 deg. F. (126.7 deg. C.)	0.85	0.81	1.40	1.37
280 deg. F. (137.8 deg. C.)	0.75	0.57	1.52	1.24

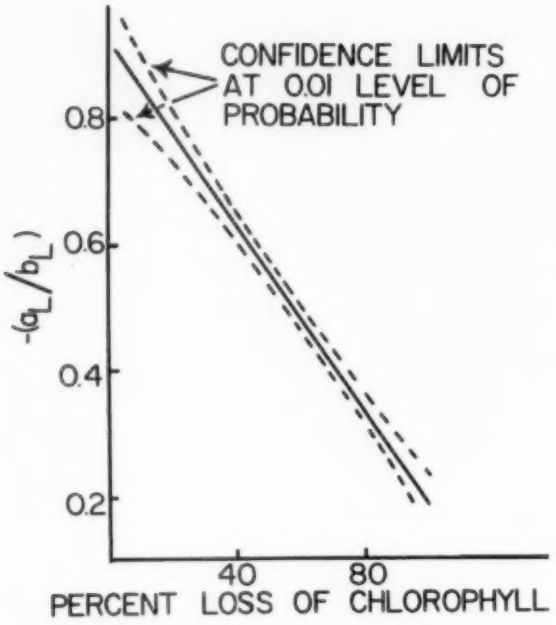

Figure 3. Regression line relating Hunter Color and Color Difference Meter values of $-(a_L/b_L)$ of peas to per cent loss of chlorophyll.

$[-(a_L/b_L) = 0.931\text{-}0.00747$ (per cent loss of chlorophyll)]

A highly significant correlation also was found between the value, $\sqrt{a_L^2 + b_L^2}$ and degree of degradation of chlorophyll. The correlation coefficient was −0.388 and the number of observations was 174.

A close correlation was found between the value R′, determined with the Bausch and Lomb Spectronic 20 Colorimeter, and the degree of chlorophyll degradation, determined spectrophotometrically. The correlation coefficient was 0.931 and the number of observations was 90. The equation of the regression line is:

$$R' = 96.47 \text{ (per cent loss of chlorophyll)} - 76.68$$

The regression line and the confidence interval at the 0.01 level of probability are shown in Figure 4.

It was shown that although chlorophyll continues to be degraded to pheophytin during storage of canned peas, the rate is less when the peas are stored under refrigeration than when they are stored at room temperature. The precise effect of refrigeration in the retention of the pigment could not be estimated, however, since only a small amount of unchanged chlorophyll remained in the peas immediately after processing. Furthermore, the samples were kept in the frozen state for some time (up to 1 year) before analysis.

DISCUSSION

The high correlation between the hue of the color of heat processed peas and the extent of chlorophyll degradation is in agreement with observations that the chief cause of the color change is the conversion of chlorophyll to pheophytin.

On the basis of the work of Mackinney and Joslyn *(15, 16, 17)*, second order kinetics might be predicted for the reaction being studied. However, considering the relative concentrations of acid and of chlorophyll in the peas(the acid is present in approximately 100 times the equivalent concentration of the chlorophyll) pseudo-first-order kinetics might be expected. A second-order effect was observed by varying the acid concentration in the pea purees.

It should be pointed out that the concept of "titratable acidity," as used in this presentation, is entirely arbitrary. It indicates only the concentration of substances in the tissue which will react with hydroxyl ion below pH 8.3. Although these substances may consist largely of carboxylic acids (chiefly malic and citric in peas [14]), other kinds of compounds, such as protein groups, amino acids, organic salts, etc., are undoubtedly involved. Moreover, the line relating the pseudo-first-order constant to titratable acidity does not pass through the origin. That is, the rate is not zero when the titratable acidity is zero.

Since pseudo-first-order kinetics have been found, the following relationship exists:

$$-d(c_{chl})/dt = kc_{chl}$$

where c_{chl} is the concentration of chlorophyll and k is the pseudo-first-order rate constant. Since k has been found to vary linearly with the titratable acidity, we have,

$$k = sc_a + i$$

where c_a is the concentration of acid, measured as titratable acidity, s is the slope of the line, and i is a constant, which must be included, since the line does not pass through the origin. As has been noted earlier, there is a simple straight line relationship between s and temperature.

It will be seen from the data in Table 2 that the rate constants for the reaction were greater in blanched than in unblanched peas, despite the fact that blanch-

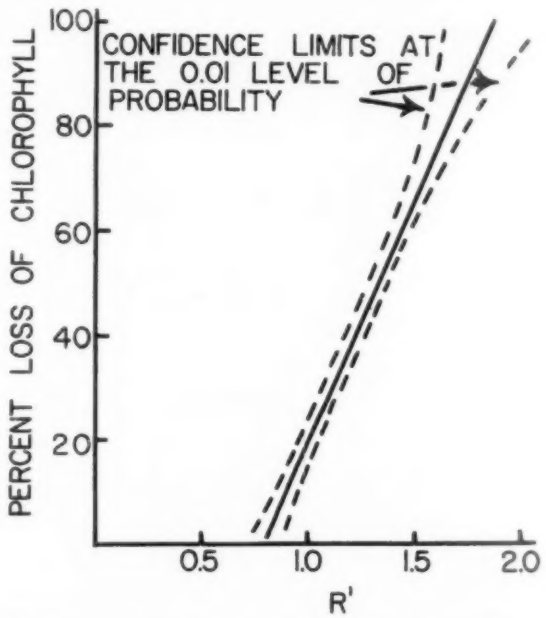

Figure 4. Regression line relating R′ to per cent loss of chlorophyll, where R′ is the ratio $\frac{\text{optical density at 536 m}\mu}{\text{optical density at 558 m}\mu}$, as determined with a Bausch and Lomb Spectronic 20 Colorimeter.

[c] Color saturation.

ing caused a decrease in the acidity of the peas. This may be due to an effect of the boiling water blanching treatment in disrupting the cellular integrity of the tissue *(18, 27)*. The hypothesis that cellular integrity has an effect upon the rate of the reaction is further supported by the fact that the rates were higher in purees, in which the acid concentration was not modified, than in whole blanched peas.

The pseudo-first-order heat of activation found in blanched peas in 1956 (15.6 Kcal.) may be considered to agree fairly closely with the value (16.1) obtained by more precise methods in 1957. The value found in unblanched peas in 1956 (16.9 Kcal.), however, is much higher than that found in 1957 (12.6). This may be due to the fact that peas used in 1956 were heat processed in a water medium in the can, which may have caused an effect analogous to that of blanching. In 1957 peas were processed in steam and were not surrounded by liquid water.

The F_0 and z values obtained by Sognefest *et al. (24)* were used to calculate the required sterilization time for pea purees of various pH values at different sterilization temperatures. The pseudo-first-order rate constants previously arrived at were then used to calculate the per cent degradation of chlorophyll that would take place during sterilization. At 240° F. (115.6° C.) it was found that 18.6 minutes would be required for sterilization of a pea puree of pH 6, and 74.1% of the chlorophyll would be degraded. At pH 7 these values are 24.6 minutes and 21.0%; at pH 8 they are 24.6 minutes and 7.43%, respectively. It can be seen then that raising the pH of the peas will have a definite protective effect upon the chlorophyll. At 280° F. (137.8° C.), the values calculated are: 0.10 minute and 1.09% at pH 6; 0.12 minute and 1.05% at pH 7; and 0.15 minute and 1.06% at pH 8. Increasing the temperature of sterilization, then, will also have a protective effect upon the chlorophyll. Raising the pH has a negligible effect when high temperatures are used for sterilization. The above values neglect any possible sterilization value and chlorophyll degradation during the "come-up" period. In the experiments during 1956 it was found that as much as 50% of the chlorophyll may be degraded during the "come-up" period in retort operation. It would therefore seem necessary to use a method of rapidly heating and cooling the peas before packing them aseptically in cans, if any benefit is to be gained from high temperature sterilization.

The close correlation between the degree of degradation of chlorophyll, as measured spectrophotometrically, and the value R′, determined with a relatively inexpensive colorimeter, indicates that the latter might be used to estimate loss of chlorophyll in routine quality control operations where a precision spectrophotometer is not available. Because the line relating R′ to per cent loss of chlorophyll may differ from the one shown in Figure 4, depending upon the colorimeter used, it is probably desirable to calibrate the particular instrument available against a precision spectrophotometer.

SUMMARY

A study was conducted over a period of two years, 1956 and 1957, to define the kinetics of the rate of degradation of chlorophyll to pheophytin during heat processing of canned green peas and pea puree under conditions similar to those employed commercially and by direct contact with steam in a specially constructed apparatus.

A quantitative relationship between the change in color of processed peas and degree of degradation of chlorophyll was determined. The following conclusions have been drawn from the data: (1) the conversion of chlorophyll to pheophytin in peas and pea purees followed pseudo-first-order kinetics; *(2)* the pseudo-first-order rate constant for the reaction in pea puree was related linearly to the titratable acidity of the puree as measured before heat processing; (3) the slope of the line relating the pseudo-first-order rate constant to titratable acidity in purees was itself linearly related to temperature; (4) pseudo-first-order rate constants for the reaction in blanched peas were higher than in unblanched peas; (5) a close correlation was found between the hue of the color and extent of degradation of chlorophyll; and (6) a rapid colorimetric method was described for estimating degree of degradation of chlorophyll. This method is considered to be applicable to routine quality control in commercial canning operations.

Acknowledgment

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Evaluation of Flavors in Meat by the Use of Aqueous Extracts[a]

(Manuscript received September 11, 1958)

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Aqueous extracts of poultry have been used in flavor studies by Bouthilet *(1, 2, 3)* and by Pippen *et al. (9)*. Grau *(6)* has shown that the higher the drying temperature, the greater is the loss of water soluble nitrogen compounds from beef and the more strawlike the flavor. He showed that the loss was not due to volatile compounds but to the conversion of water soluble materials to insoluble compounds. In 1948 Crocker *(5)* reported that a combination of pounding and squeezing in a hydraulic press, followed by three or more leachings of an hour each in water, was the best method, among several tried, for extracting flavor from beef, pork, and poultry. The materials thus obtained were subjected to the "critical, personal judgment of several workers for evaluation." To the best of our knowledge, extensive use has not been made of aqueous extracts in studies of meat flavor. Moreover, use of liquid extracts for tasting eliminates the distracting effects of texture, tenderness, and juiciness. We have found it well adapted to our needs in evaluating flavor production by a single bacterial species in experimental ham curing under completely controlled conditions *(8)*. Details will be given for the methods by which a taste panel was selected with aqueous extracts of meat, rather than meat, being used as the test material.

Aqueous extracts, so-called because water was added to the meat to be extracted, were used. Since the meat under study, cured ham, from one experiment to another contained varying amounts of free and bound ions, the extractions actually took place in salt solutions of gradually increasing concentration. Completeness of the salt extraction, or the role of concentration, if any, in removal of meat flavor was not determined.

The performance of the panel in judging similar mixtures of bouillon and meat indicated that, in respect to the problems presented by this particular investigation, bouillon prepared from aqueous extracts of ground meat was superior to cakes of meat as a material for the basis of taste testing.

[a] Presented at the Eighteenth Annual Meeting of the Institute of Food Technologists, Chicago, May 26, 1958.

MATERIALS AND METHODS

The panel was selected to evaluate the results of experiments designed to alter ham flavor during the curing process. Therefore, sensitivity to ham flavors was a requisite for panel members and dictated the general nature of materials to be used for testing in the panel selection. Two extremes in flavor, Smithfield-type cured ham and mild, rapidly cured, commercial ham were chosen, representing two widely different methods of curing. In actuality, lean meat from shoulders, subjected to a long curing period (the type used to produce old-fashioned country-cured ham) was used to obtain the Smithfield-type ham flavor. The aged shoulders were boned and the skin as well as rusty, hard, outer portions and practically all fat discarded. The meat was quite hard, hence it was chopped to the consistency of fine sawdust in the rotary blade and bowl attachment of a food cutting machine.[b] The mildly cured hams were boned, the skin and most of the fat were discarded, and the lean meat was passed twice through the ¼-inch plate of the sausage grinding attachment of the food cutting machine.[b] Ground meat, in each case, was placed in distilled water, 460 g./l., and left in the cold room at 5° C. for 48 hours. Total chloride determinations expressed as grams of sodium chloride were made on each batch of ground meat each time an experiment was run, and enough sodium chloride was added to the mildly cured meat (always the lowest in salt concentration) at the beginning of the extraction period to bring it to a salt concentration equal to that of the aged shoulder meat.

For convenience, the extractions were carried out in large beakers, which were covered tightly with aluminum foil and agitated 2 or 3 times each day. At the end of the extraction period, the ground meat was removed by filtering through a double layer of gauze. The filtrate only was saved for tasting. Some of the characteristic aged ham flavor remained in the discarded meat, based upon the opinion of experimenters who tasted cooked portions of it, but the greater part of the flavor was in the filtrate at this point. The filtrate was placed in a Florence flask, diluted with an equal volume of distilled water, and held in a boiling water bath with shaking for 15 min. During this time a practically tasteless coagulum formed from which the filtrate was decanted after standing at 5° C. overnight. Mixtures of the two 2X-diluted extracts were made such that four concentrations in respect to the 2X-diluted aged ham extract were available in two different sets of diluations (Table 1). Mixtures numbered 1, 2, 3, and 4 constituted the series used in panel selection, and those numbered 5–8, inclusively, constituted the series used in comparing meat and meat extract (Table 3). The latter series, in which the 50-50 mixture of aged and mild ham appears (No. 8), was necessary for direct comparison of meat and meat extract in organoleptic testing of flavor. A meat cake containing more than 50% of ground, aged ham would not stick together. Furthermore, a meat cake containing any more aged ham would have been readily detectable because of the great difference in texture and appearance between it and the others. This limitation in possible spread between various mixtures for ranking (standard method of panel selection regardless of flavor or material) and likewise the rather intense saltiness (5–7%) of meat mixtures containing as much as 50% aged or Smithfield-type ham were two factors inherent in using meat mixtures for panel selection. It was largely to overcome these disadvantages inherent in ham mixtures that we undertook to explore the possibility of using aqueous extracts. With these it was possible to secure high concentrations of the flavor constituents of cured ham. The concentration of flavor constituents was such as to allow dilution of salt to a palatable level (approximately 2% NaCl) while still retaining an extract of distinctly characteristic taste. The mixtures of meat extract were distributed in serological test tubes in 7 ml. quantities. The tubes were heated in a boiling water bath until the bouillon reached 60° C. Then they were each wrapped in white paper, coded, and served to potential panel members.

TABLE 1

Composition of mixtures of meat extract

Number	2X diluted extracts	
	Mild	Aged
Series 1	%	%
1	100	0
2	67	33
3	33	67
4	0	100
Series 2		
5	100	0
6	83.3	16.7
7	66.6	33.4
8	50.0	50.0

[b] Hobart Food Cutter—Hobart Manufacturing Company, Troy, Ohio. The mention of specific trade names does not constitute endorsement of the product used over comparable equipment.

TABLE 2

Composition of mixtures of meat cakes

Number	Mixtures	
	Mild	Aged
	%	%
1	100	0
2	83.3	16.7
3	66.6	33.4
4	50.0	50.0

TABLE 3

Performance of panel
Ranking four mixtures of aqueous meat extracts and meats

Material tasted	Number of tasters					Level of significance[1]
	Total	Correct		Incorrect		
		Number	Percentage	Number	Percentage	
Meat extract						
Series 1	24	16	66.4	8	33.4	.001
Series 2	20	10	50.0	10	50.0	.050
Meat	26	5	19.2	21	80.7	

[1] Determined by the Chi Square Test of significance when values for meat and meat extract were compared.

Each panel member received one of each of the 4 solutions and was asked to arrange them in order according to the content of aged ham flavor. Tubes of bouillon were served in bacteriological culture tube racks and were delivered to the desks of workers who served as taste testers. A paper cup of tap water was served with each rack. Some tasters took a sip of water between tubes of bouillon and some did not. An effort was made to serve the bouillon hot and at a worker's convenience, otherwise no consideration was given to time of day, smokers or non-smokers, or to the provision of aesthetic surroundings. Eighty clerical and technical workers who were willing to cooperate were screened for their ability to properly rank the four unknowns.

Meat cakes used in the experiment recorded in Table 3 were prepared with every possible effort to secure thorough mixing of meat and added salt. Mildly cured ham and aged shoulder were finely ground, chopped, and mixed in the proportions indicated in Table 2. Sodium chloride was added to make all batches equal in chloride content. In mixing, the ingredients of each batch were rotated and chopped together in the rotary meat cutter used for cutting the aged shoulder meat in the first place and were later mixed in a Waring blender. The cakes were cooked by boiling for 15 min. in enough water to cover them when placed flat on the bottom of a kettle with a tight fitting lid. At the end of the boiling period, the lid was removed and the water evaporated just to dryness. This was done carefully at low heat to avoid scorching the meat or depositing noticeable amounts of dissolved solids on the bottom

of the pan. Meat cakes were served cold (as aged ham usually is served) and at the desks of workers in order to make results comparable to those obtained with extracts.

The original chloride (assumed to be sodium chloride) concentrations of the seven different lots of aged meat prepared in this series of experiments ranged from 5.04 to 10.45%. The salt concentrations of the mildly cured commercial hams ranged from 3.62 to 3.93%. The chloride determinations were by the method of Kerr *(7)*. The wide variation in salt concentrations was largely the result of two factors; the percentage salt used in curing the meat, and the shrinkage or drying out of the meat in aging at 70° F. The aging process had been in progress for from one year to 16 months. The shoulders were used in a series of experiments extending over 4 months. The highest salt concentration was found in the shoulder with the highest salt concentration of the original cure.

RESULTS AND DISCUSSION

In ranking the 4 mixtures of Series 1 or 2 (Table 1) in proper order, the probability that a judge could make a correct guess was 1 in 24. Therefore, this method of screening was considered an adequate way of selecting tasters with a high degree of sensitivity for the flavor under study. In the first experiment, 30 of the original 80 tasters ranked all 4 mixtures in correct order and were therefore separated from the others on this basis. Some good judges among the 80 may have been eliminated in this first round, as sensitive tasters are known to give less than perfect performance in repeated tests *(4, 7)*. As the result, therefore, of 3 experiments in which prospective panel members were asked to correctly rank the 4 unknown ham extracts, the following scores were obtained. On the day of the second experiment only 19 of the originally selected 30 judges were present. Of these, 12 people got a perfect score in ranking. On the day of the third experiment 28 of the original 30 judges were available and 19 of these correctly ranked the 4 unknown samples. Twenty-six judges were selected to form the panel as these people properly scored the unknowns twice out of 3 trials. Six of these 26 people scored perfectly 3 times out of three trials.

The selected panel served in the evaluation of flavor in experiments reported by McLean and Sulzbacher *(8)*. It is suggested that judges who have demonstrated the ability to detect a given flavor can function with the efficiency of a precision instrument in respect to that and related flavors *(8)*.[c] In Table 3, results show that a much more accurate evaluation of meat flavor was made by the panel when meat extract, rather than meat itself, was tasted. Likewise, extracts with the greater spread between flavor levels and the lower salt concentration possible at the highest dilution (Series 1), statistically, proved far superior to the extracts of Series 2 as taste test material. The panel showed a 20 to 1 (level of significance 0.050) greater degree of discrimination in judging the meat extracts of Series 2 than in judging the comparable meat cakes. The extracts of Series 2 were directly comparable to the meat mixtures. The method in which extracts are used permits an easy and accurate preparation of various mixtures which may be brought to equal salinity. It also makes organoleptic testing for flavor possible on small experimental lots of meat. It seems likely that the immediate availability of flavor constituents in meat extracts may be a factor in the great sensitivity of taste-tests utilizing them. Grinding and extracting for 48 hours would undoubtedly remove from meat more of the water soluble constituents than could be released in the few seconds involved in chewing a bite of meat. The impact upon a subject's taste buds of extract from a given amount of ham would, therefore, probably be greater than when such an amount of ham were chewed in a single bite.

[c] The authors give credit for this comparison to Dr. Morris D. Finkner.

SUMMARY

The addition of water to ground cured ham has proved a satisfactory method of removing flavor from aged Smithfield-type cured shoulders and also from ham mildly cured by current commercial methods. Extracts of such meat were used in the selection of a panel to evaluate flavor production in experimental ham curing. The methods used are recommended for their practicability and high degree of sensitivity to differences in cured ham flavor. It is suggested that the methods would probably be adaptable to the study of other types of meat, if flavor alone were the quality to be evaluated.

Acknowledgments

The authors greatly appreciate the indispensable help generously contributed by panel members and technical assistance rendered by Mrs. Nina B. Hess. Credit is due Dr. Walter R. Harvey and Dr. Morris D. Finkner of Biometrical Services for their assistance and advice in designing the experiments and analyzing data.

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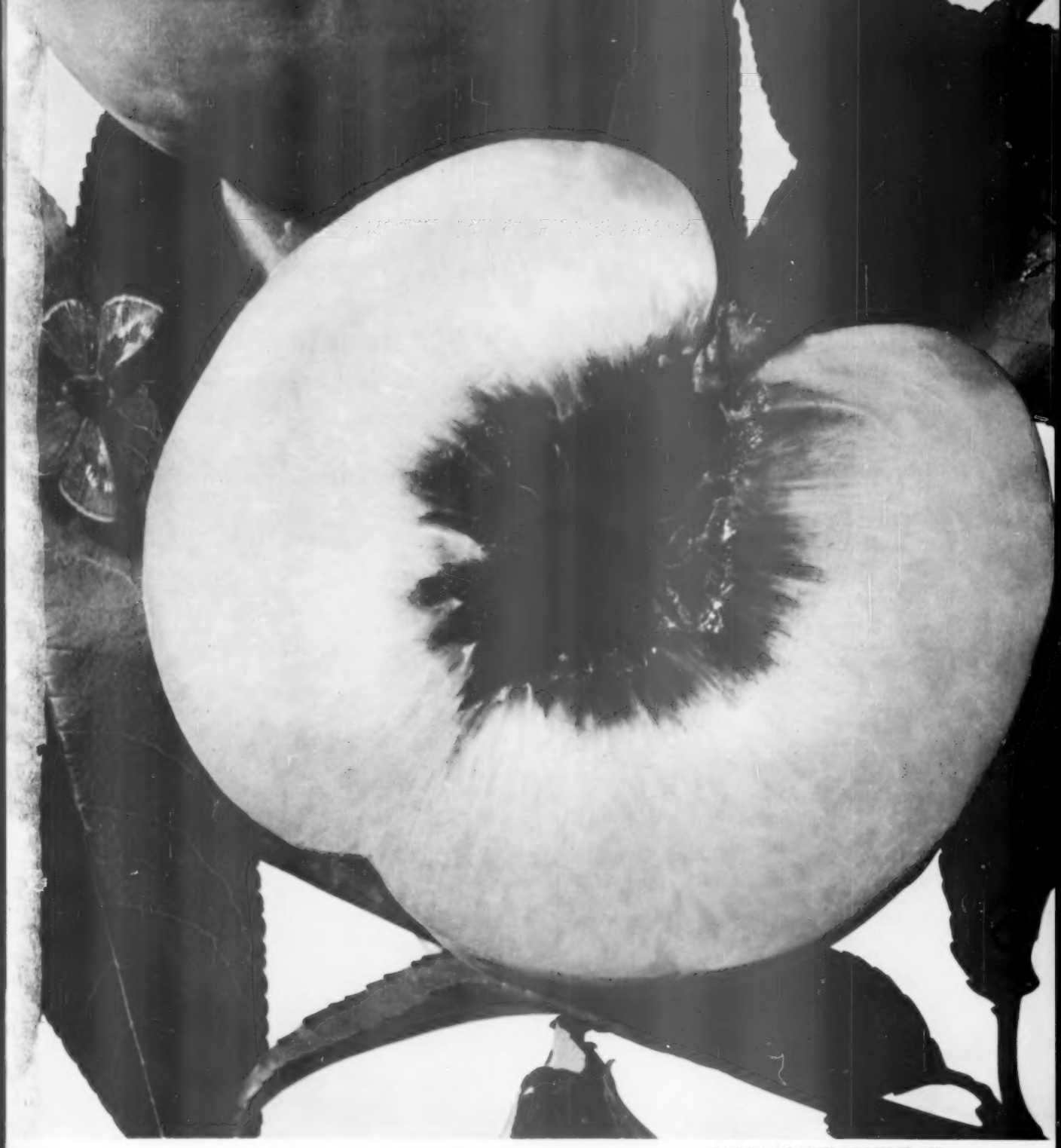

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ST. LOUIS
KANSAS CITY

"A food product can be no better than the ingredients from which it is made. Those responsible for quality control can maintain quality to the fullest within this limitation, but they cannot be expected to exceed it."

Although not accepted without discussion, these statements by Dr. A. G. Olsen largely voiced the theme of the Seventh Annual Food Technology Short Course at Columbia, Missouri, on March 13 and 14. They were echoed numerous times in the fifteen papers on quality control heard during the one and one-half day session at the University sponsored jointly by the University of Missouri and the St. Louis and Kansas City Sections.

The concept of quality control as starting with crops in the field was well brought out by Dr. Amihud Kramer of the University of Maryland. The same idea is made practical use of by Stokely-Van Camp, Indianapolis, according to Dr. D. T. Cherot of that company, by means of a program of education for the growers and regulation under contract.

Dr. H. T. Cook of the Agricultural Marketing Service USDA, described the quality factors in fruits most frequently responsible for loss in grade and measures which can be taken against these losses. Mr. L. Tobin of Scientific Associates, St. Louis, used bread crumb topping as an illustration of a complex problem in quality control, since this material must be standardized to meet the properties of at least six distinct types of foods. The need for almost instantaneous response to signs of quality deviation in the highly perishable food material shell eggs, was ably emphasized by Dr. R. H. Forsythe of Henningsen, Inc., Springfield.

Further sessions dealt with quality control in processing operations and in food products after leaving the plant. Some recent advances in the part played in this operation by the laboratory were covered in papers by Dr. O. J. Kahlenberg and Dr. C. W. Gehrke of the University of Missouri, while the tools for quality control provided by the statistician were well summarized by Mrs. Mae Tarver of Continental Can, Chicago. According to Dr. D. A. Trumbo of the Psychology Department at Kansas State College, people in this field can now plan the controls on plant equipment so as to minimize human error. Some qualities which deteriorate in frozen and fresh foods and steps which can be taken to delay this process were described by Mr. R. C. Maxon and Dr. J. E. Edmonson of Missouri, while Mrs. Mahla Ivey reported on a study of refrigeration conditions in the home. The stringent stability requirements peculiar to military foods and recent progress made toward meeting these requirements were reviewed by Dr. R. B. Koch of the Quartermaster Food and Container Institute. Mr. F. Judell of Ralston Purina, St. Louis, brought us up-to-date on the federal and state laws which govern the quality of foods.

Over the years, the Short Course has been one of the outstanding gatherings for food technologists in and around the state of Missouri and it was a pleasure again to see over 200 of our old friends. A great feeling of solidarity has been built up here between the St. Louis and Kansas City Sections and we remain grateful to the University, both as a host and for bearing the major burden in the arrangements.

N. CALIFORNIA

Mr. Ray Wakefield, President-Elect of the Institute of Food Technologists, was the speaker for the March meeting. The requirements of the future—the "Space Age" is a challenge for which the food industry must prepare—demand that the food industry initiate considerable research in food processing, product development, and packaging. As an example, a breakthrough in processing technology, involving a combination of such techniques as Radiation-Sterilization, Freeze-Drying and the use of antibiotics, can be anticipated in the near future. Two factors which will add impetus to these developments, the speaker suggested, are the demands of an increasing population and the desire for more of the convenience foods. While the Army is undertaking research in methods for the more efficient feeding of the armed forces, the investigation of food products for the general populace will depend upon private industry. Thus the Food Technologist bears a challenging responsibility to the future welfare and progress of the country.

The Bay Area Section of the American Society for Quality Control participated with us in a joint meeting on April 13 at the Cottage Restaurant, Oakland, California. "Practical Applications of Statistical Quality Control in Food Processing" was the subject on which Dr. Harold L. Stier spoke to the combined groups. Dr. Stier is Director of the National Canners Association's Division of Statistics.

The American Society for Quality Control is a nonprofit, educational and scientific Society composed of over 12,000 members in the fields of quality control, inspection, research and development, statistics and engineering. Its purpose is to create, promote and stimulate interest in the advancement and diffusion of the knowledge of the science of Quality Control and of its application to industrial processes. In the Bay Area, more information can be obtained by contacting the Vice Chairman, Stanley Hotchner, American Can Co., Technical Service Division, San Francisco, HE 1-6875.

Our section was recently honored by the appointment of Dr. Emil M. Mrak as Chancellor of the University of California, Davis, California. He was formerly head of the Food Technology Department, University of California, Davis.

Plans are being formulated for our annual picnic on Saturday, June 6.

—Shirley V. Noland

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Literature

BOOKS

LIVING RESOURCES OF THE SEA: OPPORTUNITIES FOR RESEARCH AND EXPANSION. Lionel Walford. The Ronald Press Co., New York, N. Y. 1958.

"A pound of starch is the most important grocery item in the world. More than a billion men, women and children live on just about a pound of starch a day, seldom more, never less—for there seldom is more and one can't live on less. It takes a pound to tip the scales of life to death's disadvantage. Fortunately, most of these persons get their pound of starch —fortunately not only for them, but for the rest of us. Life wouldn't continue as we know it if death began to sweep among so many human beings no matter how far off they are. The world's tranquility, such as it is, rests in part with that measure of rice in Asia, corn in Peru and manioc in Africa."

This quotation, a portion of a recent N. Y. *Times* editorial, points up the severity of the food-population dilemma. The problem of men and hunger is a very real, very tragic one. How to feed these men and alleviate hunger is being given a good deal of consideration these days. The ever increasing literature on the relationship between food supply and rocketing population reflects the urgency placed upon science and technology with each passing year.

Most, if not all writers on this subject have suggested remedies. Among the suggestions advanced have been the exploitation of the resources of the seas. Although impressive calculations have been presented to support the idea that the sea is an untapped reservoir waiting to be dipped into, little has been written about the attendent practical difficulties. Recently, however, a book, the subject of this review, has been published that considers the sea as a source of additional food but does not have any 'pat' answers. Actually, this is a book of questions; posers, stunners and simple quests for information not available. The questions, and discussion about them, set forth a challenging thesis which results in provocative reading.

Should people have enough to eat?

This book does not work up to a high point or a climax. It starts right off by asking, "Is it necessary that the majority of the people in the world should never have enough to eat"? With that, the author is on his way and never lets up. The answer to that stunner may be contained in the text, but it is not directly spelled out. The web of problems that must be explored mitigate against a yes or no answer. Chapter one seems to be directed to those in the community who believe that fundamental research is just so much "aimless pottering." To these people Lionel Walford points out that such commonplace modern marvels as TV, airplanes, wonder drugs etc., were the products of earlier "impractical" studies. A great gathering of basic information is called for, from which a system of principles can be derived.

Chapter two consists of a series of 14 colored maps (The Breismeister new equal-area projection) which attempt to describe graphically the population-protein-poverty regional triumverate. Perusal of these maps suggests why the initial question is not easily answered.

Although Walford calls for a Philosophy of Fishery Conservation, he is no idle dreamer. Underlying all his thinking is the hard fact that trained scientists and equipped laboratories must come before any substantial increases in food yields can be delivered from the waters.

Some potshots at the pot boilers

The fact that the author is a Government official himself does not prevent his taking potshots at other officials for their repetition and preservation of hack ideas. His easy style serves him well in taking to task the conformists, deadwood, and "pot boilers" that pervade the field and maintain the status quo. Describing the "perfunctory" literature on fishery conservation he drops the proverbial bombshell when stating that "most of it advances no new thought at all; it merely repeats what has been said before, using uncritically the same examples to support the same arguments over and over. This state of affairs results largely from the fact that the bulk of the literature is produced by government administrators to order, on short notice." "Some of the general literature which attempts to deal with the large questions is produced by college professors who are familiar with soil technology or geology or forestry, but who are not authoritative on fishery resources. They make up for this lack by reading and paraphrasing Government pamphlets or by inveighing Government specialists to write the chapter on fishes for their texts. The results usually have the dreary quality of pot boilers." In addition, his questions deflate many notions held by amateurs and points up the harm they can do especially by influencing legislators.

Though Conservationists will not fall over themselves trying to shake Walford's hand, Systematists most surely will—but only figuratively. Their ranks are too thin to cause any real jam up. In chapter four, the author attempts to bring about their resurrection by calling for financial support for their very important endeavors. He bases his support on the truism that research into resources depends in very large measure on identification of species and populations.

Although Walford presents a tight case for extensive research into the 12 major problems, (Chapters 1–12) one wonders if he means to have all the data "in" before the first mouths are fed. Probably not, but the feeling is about.

The dream of feeding the burgeoning world population with products from the sea relies heavily on the hope that huge untapped reservoirs of virgin stocks and new species will be found in the unexplored depths of the sea. Chapter 5, describing the Sea Environment, attempts to place this notion in

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proper perspective. However, the author does indicate that knowledge of the intricate relationships among animal and animal, animal and plant, and the physical-chemical surroundings can lead to increased productivity and thus greater yields from the sea. Many examples of how one organism may influence the presence and thereby the catch of another (form) are presented. Understanding the interrelationships of the marine ecosystem will be a formidable task. Chapter 6, Uses of Ecological Principles, is actually an extension of Environment, but stresses the application of findings to the establishment of a science of fisheries. The possible reasons for fluctuations in populations are explored.

The chapter dealing with Behavior, explores the problems of more economical and intensive fishing. Understanding the behavior of fish is the first requisite to developing means to catch them. Knowledge of their movements, feeding habits, predation and attraction to bait could aid in designing more efficient equipment and techniques. The diets, food habits and religious restrictions of the people to be fed, must be studied and a program of education undertaken before 'new' foods can be introduced, let alone, established. Here again, the author does not offer encouragement. He does believe that gathering of firm data would provide means for an intelligent opinion.

Hope in aquiculture

After perusing chapter nine, Farming the Brackish waters, the reader breathes easier. At last the author admits of an area that appears to offer a means of feeling the still hungry people. Aquiculture, in the inshore waterways protected from the open ocean, has apparently proved itself in the East Indies, Formosa, and the Philippines. It is in aquiculture, that the per acre yield of protein is considerably higher than for farmland. In Formosa, yields of 800–1200 pounds of fish per acre (wet weight) are not uncommon. Walford believes that extending this practice around the world offers the possibility of the greatest yield for the expense. Sufficient data on pond design, maintenance and stocking (species) has been collected to bolster his belief.

Closing Part I, there is a most interesting discussion of the vessels and gear used around the world and how their improvement could increase yields manyfold. In underdeveloped regions, the simple expedient of adding an out-board motor to dug-out canoes would increase the catch considerably. But the problems created hereby seem to skyrocket. Fuel would be needed; docks, storage tanks, roads and distribution centers would need to be constructed. Motor repair ships would be needed. Mechanics would have to be trained. Fisherman must be taught to operate and care for the motors. Means would have to be provided to preserve and store the additional catch; to sell and distribute them to distant markets. With these myriad problems, one wonders if birth control has a place in the over-all problem. The author believes it does, but here religious barriers present yet additional problems.

Part II, Resources of the Sea, consists of five chapters, each detailing a potential resource: the invertebrate animals; fishes, reptiles; the marine mammals and seaweeds. Each of these groups is considered as a source of food or medicinals, but the evidence is not at all encouraging that one of these forms will be the 'horn of plenty.'

In summing up, Dr. Walford presents what at first glance seems to be a startling answer to the problem of feeling the hungry people. He advocates the training of more scientists!

Living Resources of the Sea is unreservedly recommended.

MELVIN A. BENARDE
Crisfield, Maryland

FOOD MICROBIOLOGY. W. C. Frazier. McGraw-Hill Book Company, Inc., New York. 1958. 472 pp.

This book is a well written digest of the basic principles of food microbiology. Among the recent advances covered are the utilization of radiation and antibiotics in food preservation.

The subject matter in this volume has been divided into six main parts: (1) the microorganisms important in food microbiology, their characteristics and their entrance into foods; (2) the preservation of foods, including basic methods and their application to specific foods; (3) the general principles concerned in the spoilage of foods and the spoilage of specific foods; (4) foods and enzymes produced by microorganisms; (5) food in relation to disease, with emphasis on food poisonings and infections, and (6) food sanitation, control, and inspection.

The first section, which covers microorganisms important in food microbiology, gives a good brief outline of the identification and classification of food molds, and a short discussion of the classification of yeasts. The author devotes one chapter to genera and groups of bacteria important in food bacteriology.

In the section on the preservation of foods there is a good discussion of the principles involved in the various methods, and illustrations of the use of these methods in the preservation of the main groups of foods. This discussion is the most comprehensive treatment given any of the general headings. In the following section there is an almost equal amount of space devoted to a discussion of the spoilage of foods resulting from the failure of these preservation methods. Although the discussion deals primarily with spoilage of food by microorganisms, there are adequate examples cited which emphasize that the growth of microorganisms is not the only cause of the deterioration of food. In this section there are chapters covering the factors influencing the spoilage of each of the following groups of foods: cereals and cereal products; sugars and sugar products; vegetables and fruits; meats and meat products; fish and other seafood; eggs and poultry; milk and milk products; miscellaneous foods, and heated canned foods.

The short section on foods and enzymes produced by microorganisms gives a good brief introduction to this fascinating phase of food microbiology.

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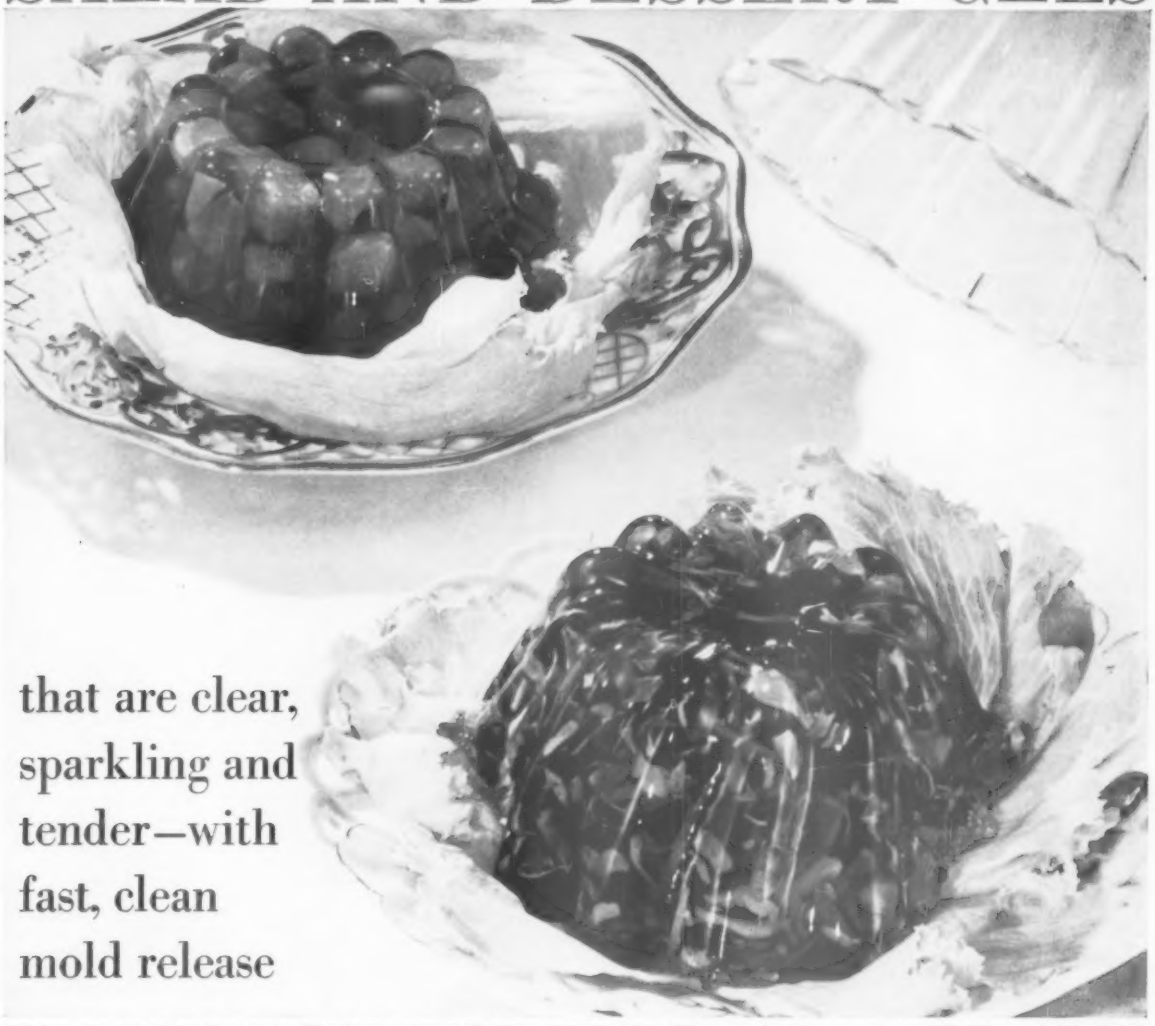

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The fifth section presents an excellent concise discussion on foods in relation to disease. There is one chapter devoted to a brief summary of the techniques used in investigating food-borne disease outbreaks.

In the final section food sanitation, control, and inspection have been considered primarily from the microbiological standpoint. The bacteriological aspects of the Federal Food, Drug, and Cosmetic Act are discussed briefly.

This book will be criticized by some for giving relatively limited coverage to certain food products of major importance. Where this is the case, one can readily check the reference lists at the end of the pertinent chapters and find references to adequate recent books or review articles for more detailed information.

The author has made this book brief enough for use as a textbook for a junior level college course, and complete enough to include all subject matter usually presented in a course in food microbiology. Research and products control workers in government, industrial and private laboratories will also find much useful information in this volume.

R. O. WAGENAAR
Minneapolis, Minnesota

LITERATURE ON FOOD RESEARCH AND FOOD TECHNOLOGY *

Commodities

Business management of frozen food locker and related plants. J. J. Mullen and L. M. Deboer. Washington, 1958. 93 p. (U. S. Dept. of Agr. Marketing research report, 258.) pap. apply.

Canned cooked rice; the market potential for a new food product. R. V. Enochian, J. S. Hunter, and R. G. Harris. Washington, 1958. 49 p. (U. S. Dept. of Agr. Marketing research report 249.) pap. apply.

Costs of peeling potatoes by lye and abrasive methods. W. S. Grieg and A. C. Manchester. Washington, 1958. 38 p. (U. S. Dept. of Agr. Marketing research report 255.) pap. apply.

Frozen food. Leaflet R5, Extension Service, U. of Massachusetts, Amherst, Mass. A guide for the frozen food handler.

Palatability and vitamin C content of Maine-grown broccoli. E. F. Murphy. Orano, Me., 1958. 15 p. (Maine Agricultural Experiment Station. Bulletin 574.) pap. apply.

[*Processing fruits and vegetables on collective farms.*] Pererabotka plodov i ovoshchei v kolkhoz akh. R. Ia. Tkachev. Moscow, Gos. izd-vo sel'khog. lit-ry, 1958. 174 p. In Russian.

Production of canned pulp-fortified red grapefruit juice. B. J. Lime, T. S. Stephens, and F. P. Griffiths. Washington, 1958. 10 p. (U. S. Dept. of Agr. Agricultural Research Service. ARS-72-12.) pap. apply.

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Food industries manual; a technical and commercial compendium on the manufacture, preserving, packing and storage of all food products. [Rev. ed.] New York, Chemical Pub. Co., 1958. 979 p. $16.00.

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[*Chemical control in the process of making wine from fruits and berries.*] Tekhnokhimicheskii kontrol' plodovoiagod vinodeliia. R. D. Begunova and O. S. Zakharina. Moscow, Pishchepromizat, 1958. 141 p. In Russian.

Chemistry of industrial toxicology, 2nd ed. Hervey B. Elkins. New York, John Wiley & Sons, 1959. 463 p. $11.50. Thirty-three pages of bibliography. First edition was issued in 1950.

Organic synthesis, v. 38. John C. Sheehan, ed. New York, John Wiley & Sons, 1958. $4.00. Another in the annual series of basic methods in organic synthesis.

Rapid peroxidase test for better control of blanching. H. J. Morris. Washington, 1958. 7p. (U. S. Dept. of Agr. Agricultural Research Service. ARS-74-10.) pap. apply.

The safety of polyoxyethylene (8) stearate for use in foods. Report of the Food Protection Committee of the Food and Nutrition Board, December 1958, Publ. 646, National Academy of Sciences, National Research Council, Washington 25, D. C.

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Food microbiology. W. C. Frazier. New York, McGraw-Hill, 1958. 472 p. $9.00.

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Source book on gibberellin, 1928–1957. F. H. Stodola. Washington, 1958. 422 p. (U. S. Dept. of Agr. Agricultural Research Service. ARS 43-78.) The uses seem to be expanding.

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Reprints available for distribution, 10 March 1959. Chicago 9, Illinois, Technical Services Office, Quartermaster Food and Container Institute, 1819 West Pershing Road, 1959. 11 p. mimeographed. A list of 169 reprints of journal publications.

Scientific translation; a guide to sources and services. Sheila M. Parker. Rev. by Rosemary Roberts and Miriam Hawkins. Washington, U. S. Govt. Print. Off., 1959. 19 p. pap. $0.15. A Public Health Service publication with authors at the National Library of Medicine and the National Institutes of

* Material for this list should be sent to Dr. James G. Hodgson, Chief, Library Branch, Quartermaster Food and Container Institute for the Armed Forces, 1819 W. Pershing Road, Chicago 9, Illinois.

Health. A revision of a pamphlet issued in 1957. There is still no concerted effort to translate in food technology.

Miscellaneous

Health of a nation: H. W. Wiley and the fight for pure food. O. E. Anderson. Chicago, University of Chicago Press, 1958. 322 p. $6.00.

Getting the most out of frozen foods. Leaflet C12. U. of Massachusetts, Amherst.

Planning new products. Philip Marvin. Cleveland, 13, Ohio, Benton Publishing Company, 1958. 102 p. pap. $3.00. Measuring company needs in new product development.

Scientific manpower in Europe: a comparative study of scientific manpower in the public service of Great Britain and selected European countries. Edward McCrensky. New York, Pergamon, 1959. 197 p. $6.50. Comparison of pay and treatment in government and private industry, with some material on Russia and the United States.

The simplicity of science. Stanley D. Beck. Garden City, N. Y., Doubleday, 1959. $3.75. Philosophical discussion of the meaning and significance of science. Author, a zoologist, is Assoc. Prof. at the University of Wisconsin.

ABSTRACTS

—Compiled by H. A. Campbell

ANALYTICAL METHODS

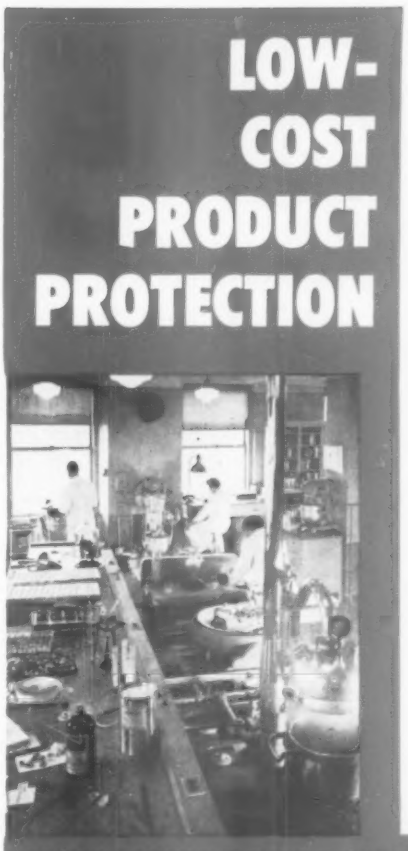
Analytical separations in the study of limonene sulfides.

Weitkamp, A. W. (Standard Oil Co., Whiting, Ind.). *Perfumery Essent. Oil Rec. 49*, 803–7 (1958).

Gas chromatography, because of its small sample requirement, is ideally suited for research on flavor and odor components. Thiourea adduction, at least as a qual. test, can also be used on a micro-scale by observing adduct formation with the aid of a microscope. In the study of limonene sulfides the larger-scale separative processes, distn., adduction, and crystn., were helpful in obtaining samples for identification. Gas chromatography was an excellent tool for the study of reaction variables because it conserved materials and provided compn. data with a minimum of time and effort.

Analysis of long-chain fatty acids by gas-liquid chromatography. Micromethod for preparation of methyl esters.

Stoffel, W., Chu, F. and Ahrens, E. H. (Rockefeller Inst., New York City). *Anal. Chem. 31*, 307–8 (1959).



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An essential prerequisite for the analysis of lipide mixts. of biological origin by gas-liquid chromatography (GLC) is the quant. formation and isolation of the constituent methyl esters. A micromethod is described involving interesterification with methanol and hydrochloric acid. By sublimation the methyl esters are isolated from the reaction products in a pure form ready for gas-liquid chromatography. The methylation and sublimation can be done with ease on a large number of samples. This method eliminates the use of alkali and diazomethane, which may lead to isomerization or pyrazoline formation.

Qualitative aldehyde reaction. Identification of amino acids.

STORHERR, R. W. (Dept. of Chem., Georgia Expt. Sta., Experiment). *Anal. Chem. 31*, 268–70 (1959).

Aldehyde-amino acid reactions in glacial acetic acid soln. furnish a new means for the identification of specific amino acids. 2-Furaldehyde reacts with most amino acids to produce a common absorbance maximum in the range 360 to 380 mμ. The lysines and ornithine in addn. have a second maximum in the range 515 to 530 mμ specific for this group of diamino acids. s-Trioxane reacts specifically with hydroxyproline, furnishing an absorbance maximum at 492 to 494 mμ. Only milligram amts. of original protein are required for the identifications.

Silicic acid chromatography of lipids of whole human blood.

WREN, J. J. AND MITCHELL, H. K. (Kerckhoff Labs. of Biol., California Inst. of Technol., Pasadena). *Proc. Soc. Exptl. Biol. Med. 99*, 431–5 (1958).

Chromatography on silicic acid columns is a powerful tool for the sepn. of blood lipids. In one expt. about 30 different lipids may be detected; some of these remain unidentified.

BIOLOGICAL SCIENCES

Biochemistry

A rapid paper chromatographic procedure for the quantitative determination of hydroxyproline.

ROBERTS, H. R., KOLOR, M. G. AND BUCEK, W. (Natl. Dairy Products Corp., Oakdale, N. Y.). *Nature 182*, 1602 (1958).

In a recent communication, the authors described a descending paper chromatographic procedure for the quant. detn. of hydroxyproline which required a solvent development of 40 hrs. Using horizontal paper chromatography at an elevated temp. comparable results have been obtained after development for only 4 hrs. The accuracy and precision of this rapid paper chromatographic procedure was established by detg. the hydroxyproline content of a soln., pH 6.5, contg. 18 common amino acids. The average value of 9 chromatograms, 47.7 mg./100 ml., differed from the theoretical value by 1.9%.

The relation of ascorbic acid to the conversion of proline to hydroxyproline in the synthesis of collagen in the carrageenan granuloma.

ROBERTSON, W. B., HEWITT, J. AND HERMAN, C. (Dept. of Biochem., Univ. of Vermont, Burlington). *J. Biol. Chem. 234*, 105–8 (1959).

Uniformly labeled proline-C^{14} was administered for 3 days to guinea pigs bearing carrageenan granulomas which were removed 12 hours after the last injection. Hydroxyproline or proline, or both, were isolated from collagen and noncollagen fractions and their specific activity were detd. The concn. of hydroxyproline and its specific activity in collagen from the vitamin C deficient animals were, resp., 20% and 60% of the normal, whereas the respective values for animals recovering from ascorbic acid deficiency were 90% and 180% of normal. Thus, ascorbic acid appears to be required for maximal conversion of proline to hydroxyproline in this system. The data do not support the hypothesis that proline-rich, hydroxyproline-deficient precursor of collagen accumulates in the vitamin-deficient granuloma.

Effect of methionine on the biochemistry of the liver.

PROSKY, L. (Rutgers Univ., New Brunswick, N. J.). *Dissertation Abstr. 19*, 1197 (1958).

Rat feeding studies were used to det. changes in protein efficiency of casein due to supplementation; influence of the diet on the concns. of protein, fat, and nucleic acids in the liver; the incorporation of S^{35} from methionine into the serum and liver proteins; and the specific effects of methionine and other supplements on serum proteins.

Observed and calculated R_f values of several synthetic peptides in paper chromatography.

MOORE, T. B. AND BAKER, C. G. (Natl. Insts. of Health, Bethesda, Md.). *J. Chromatography 1*, 513–20 (1958).

To supplement extensive information on peptides and amino acids, data were obtained on the paper-chromatographic behavior of 88 synthetic peptides and 29 amino acids in 15 solvent systems. Theoretical R_f values were calcd. for 46 peptides in 9 solvent systems and were found to be in good agreement with the observed values.

Microbiology

Recommended methods for microbiological examination of frozen fruits, vegetables and precooked foods.

GORESLINE, H. E. (The Am. Public Health Assocn., New York City). *Quick Frozen Foods 31*, 119–21 (Oct. 1958).

In testing frozen fruits and vegetables for microbiol. content, consideration must be given to the fact that freezing storage at temps. of −10° F. brings about a reduction in viable microorganisms. It is also recommended that in the prepn. of samples of frozen fruits and vegetables for microbiol. analysis, a mechanical "blender" be employed. Methods for the microbiol. examn. of peas, broccoli, asparagus are described.

Inhibition of Clostridium botulinum and mold in aged, surface ripened cheese.

GRECZ, N., WAGENAAR, R. O. AND DACK, G. M. (Univ. of Chicago, Illinois). *Appl. Microbiol. 7*, 33–8 (1959).

Two types of surface ripened cheese have been shown to become inhibitory to the growth and toxin production of *Clostridium botulinum* and to the growth of several *Penicillium* molds after storage at 2 to 4° C. for 8 weeks or longer. Cheese stored for a shorter time than 8 weeks supported growth and toxin production of *C. botulinum* exhibiting optimum conditions after 4 to 6 weeks of storage.

Agitation-aeration in submerged fermentation. I. A comparative study of the sulfite and polarographic methods for measuring oxygen solution rates in a fermentor.

STEEL, R. AND BRIERLEY, M. R. (Coll. of Sci. and Technol., Manchester, Engl.). *Appl. Microbiol. 7*, 51–6 (1959).

Although the submerged aerobic cultivation of microorganisms has become an established feature of the present-day fermentation industry, equipment design and operation have been based largely upon empirical studies. Attention has been directed to the problems of supplying sufficient oxygen to microbial cultures and to methods for defining aeration efficiency in fermentors. The sulfite oxidation method for determining oxygen soln. rates in a fermentor has been used to test the efficiency of equipment design as a parameter for increase in scale or as a measure of the actual amt. of oxygen transferred to a microbial culture.

Nutrition

Vanderbilt cooperative study of maternal and infant nutrition.

MCGANITY, W. J., BRIDGFORTH, E. B. AND DARBY, W. J. (Dept. of Obstetrics and Gynecol., Vanderbilt Univ. School of Med., Nashville, Tenn.). *J. Am. Med. Assoc. 168*, 2139–45 (1958).

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Observations on a total obstetric clinical population of 2,338 women have been made. There was a decrease of approximately 200 calories in the average intake between the second and third trimester. This was assocd. with a similar decrease in the consumption of most of the individual nutrients. There were also changes in blood constituents. From the present study, it is clear that dietary intakes, greater than the Recommended Dietary Allowances of the Food and Nutrition Board do not bestow addnl. protection benefits during pregnancy. It appears that the recommended standards for calories are too high for the expectant mother of today. A dietary that will provide the essential nutrients without supplements is readily attainable from food sources. The common obstetric routine of broad-spectrum nutritional supplementation is questioned.

In vivo protein digestion.

ANON. *Nutrition Revs. 16*, 334–6 (1958).

Adult male rats were trained to consume the daily ration during a single 2-hour period each day. Rats trained in this manner were offered 6 g. of a basal diet contg. 15% of various proteins. The animals consumed 4 to 5 g. of diet in 10 to 15 min. and were then sacrificed at regular intervals after feeding and the contents of the stomach and intestine were analyzed for N as a measure of rate of disappearance of dietary protein. This procedure established that beef proteins, casein, zein and amino acid mixts. passed from the stomach at about equal rates for the first 2 hours after feeding. During the periods about 60% of the ingested N disappeared. Dietary constituents consumed with protein were noted to influence its disappearance. Free amino acids did not disappear from the digestive tract more rapidly than intact proteins suggesting that the rate of digestion is not a limiting factor in protein utilization unless the protein is relatively insol.

Intestinal permeability to proteins.

ANON. *Nutrition Revs. 16*, 342–4 (1958).

The newborn calf, foal, lamb, kid and pig are able to absorb certain proteins from the colostrum and these proteins then appear in the animal's blood. These proteins may play an important role in increasing the resistance of the animals to a variety of infections. There is a period of only one or two days following birth during which this absorption of proteins can occur and coincides with the period during which they appear in the dam's colostrum. Although colostral proteins other than those appearing in the globulin fraction of the blood are absorbed by the newborn animals, the other proteins are excreted in the urine.

Proteinuria in rats and mice.

ANON. *Nutrition Revs. 16*, 337–40 (1958).

Recent work on the urinary excretion of proteins by rats suggests very strongly that these animals routinely excrete small fractions of certain serum proteins. The excretion of these proteins by the kidneys is influenced to a considerable extent by testosterone.

Diet and portal vein pressure.

ANON. *Nutrition Revs. 16*, 298–9 (1958).

Direct measurement of portal vein pressure in dogs showed a rise after protein feeding which was greater in some dogs with chronic liver disease. These findings suggest that high protein feedings may be harmful to certain cirrhotic patients by aggravating portal hypertension with its attendant risks of gastrointestinal hemorrhage and ascites.

Terminal phase of dietary liver necrosis in the rat (hepatogenic hypoglycemia).

SCHWARZ, K. AND MERTZ, W. (Natl. Insts. of Health, Bethesda, Md.). *Metabolism: Clin. and Exptl. 8*, 79–87 (1959).

The symptoms and the sequence of events during the terminal phase of dietary liver necrosis in the rat were investigated. The most consistent symptoms found in 150 carefully observed animals were weakness and decline of body temp. 1 to 2 days before death, subsequent gradual loss of consciousness and spasms and serious convulsions during the last 30 minutes. These signs disappeared promptly upon intravenous injection of glucose. The significance of hepatogenic hypoglycemia and its occurrence in human liver diseases are discussed.

Hereditary galactose disease.

GUEST, G. M. (Univ. of Cincinnati, Coll. of Med., Ohio). *J. Am. Med. Assoc. 168*, 2015–19 (1958).

Where there is an inability to metabolize lactose and galactose, early diagnosis is of the greatest importance since the deleterious effects of this disorder increase with its duration. The main symptoms usually appear by the time the infant is one or two weeks of age, making early recognition possible. Appropriate treatment is primarily the omission of milk and other foods from the diet.

Studies on dietary lipids.

ANON. *Nutrition Revs. 16*, 331–4 (1958).

Male rats were employed in dietary fat digestibility studies. 100% digestibility was obtained for even numbered fatty acids contg. 4 to 10 carbon atoms. With fatty acids of longer carbon chain length the digestibilities decreased progressively with stearic and behenic acids yielding digestion coeffs. of 12 and 7% resp. Mono-unsatd. fatty acids were more digestible than satd. acids. Methyl esters of fatty acids were somewhat more digestible than their corresponding free acids. The authors point out that the melting point of a fat cannot reliably serve as a prediction of its digestibility. Calcium content of the diet plays an important role in fat digestibility as it affects fecal fat excretion in the form of soaps.

Effect of sodium salicylate on the food and oxygen consumption of rats.

BECKER, E. J. (Dept. of Physiol. Sci., Dartmouth Med. School, Hanover, N.H.). *J. Nutrition 66*, 237–44 (1958).

The exptl. data presented indicate that young rats when fed diets contg. moderate amts. of sodium salicylate, grow normally and oxidize about the same amt. of food as animals on a normal diet, contg. no salicylate. Their oxygen consumption does not differ substantially from that of normal animals; the differences found between animals fed the basal diet and those which received 0.1%, and 0.25% of salicylate are probably within the errors of the techniques employed in the expts.

Thermochemical efficiency of growth.

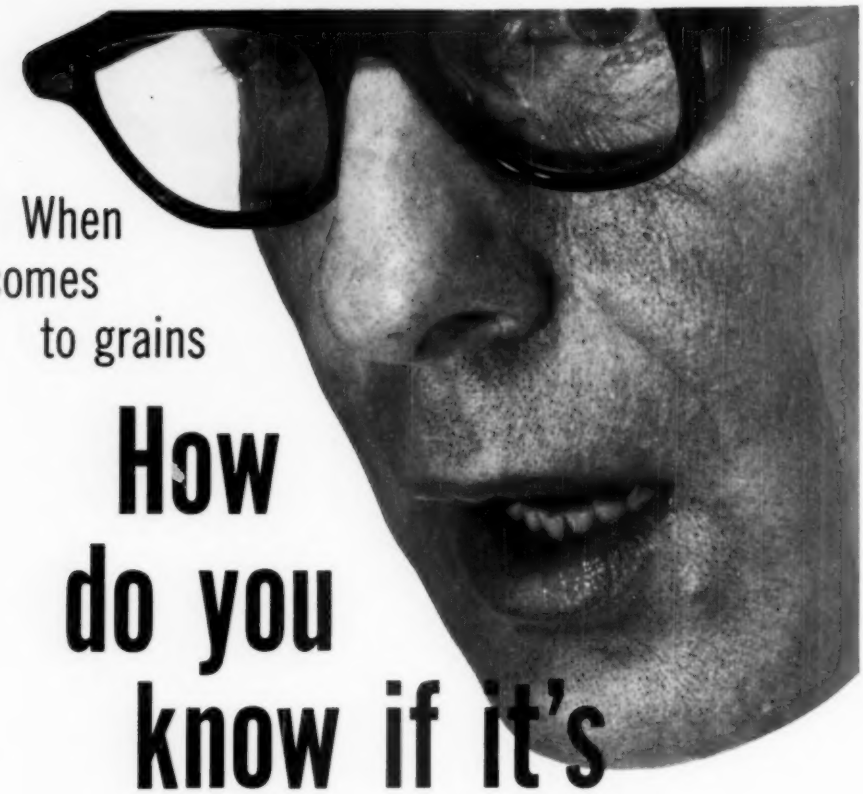
ANON. *Nutrition Revs. 16*, 279–81 (1958).

These expts. add to the general fund of reference data available for the rat and emphasize the importance of including changes in carcass analysis in estimating the efficiency of calorie utilization. Observations from this study emphasize that where measurements of calorie utilization are made without carcass analyses, expts. of short duration would provide more reliable information than long term studies.

Absorption of vitamin B_{12} in pernicious anemia. Defective absorption induced by prolonged oral treatment.

SCHWARTZ, M., LOUS, P. AND MEULENGRACHT, E. (Bispebjerg Hosp., Copenhagen). *Lancet 7058*, 1200–3 (1958).

The blockage of absorption of vitamin B_{12} caused by oral treatment of pernicious anemia with prepns. of vitamin B_{12} plus hog pyloric mucosa, was demonstrated. Such blockage is very common, and it often occurs after treatment for a few months. Patients treated with prepns. of crude pylorus develop this blockage. Vitamin B_{12} bound to this substance is poorly absorbed despite the presence of active human intrinsic factor. The blockage is



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  FARINA
- **Pre-Mixing Services**
  AVAILABLE (to your specs)
- **Rice Products**
  FLOURS
- **Barley Products**
  PEARLED BARLEY...7 sieve sizes
  BARLEY FLOURS (including one in which the enzymes have been inactivated)
- **Corn Products**
  (all electrostatically cleaned – then water washed before milling
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  GRITS.....White & Yellow
  FLOURS.....White & Yellow

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not present in absorption tests with homologous intrinsic factor, nor with intrinsic factor from another species (rat). This observation supports significantly the hypothesis that blockage is an immunity phenomenon, the intrinsic factor being to some extent species-specific.

Pantothenic acid, ascorbic acid and intestinal microflora.

ANON. *Nutrition Revs. 16*, 305–7 (1958).

Male weanling rats were fed a pantothenic acid deficient diet. The inclusion of 2% ascorbic acid in the diet prevented symptoms of pantothenic acid deficiency in most cases. When ascorbic acid was fed simultaneously with sulfathiozole (2%) the ascorbic acid failed to protect against pantothenic acid deficiency. Since sulfathiozole inhibits the activity of intestinal microorganisms these results suggest that ascorbic acid deficiency prevention is also mediated through changes in intestinal flora.

Physiology

Gastric emptying and intestinal absorption of carbohydrate and proteins as influenced by the nature of the test meal.

ROSENTHAL, S. AND NASSETT, E. S. (Dept. of Physiol., School of Med. and Dentistry, Univ. of Rochester, N. Y.). *J. Nutrition 66*, 91–103 (1958).

It was demonstrated that the stomach empties its contents in an exponential fashion. The rate of emptying appeared to be detd. by the dietary sources of carbohydrate, which were fresh banana and dextrin. The absorption of carbohydrate was a linear function of gastric emptying. The recovery of protein from the small intestine tended to remain constant over a period of 6 hours, during which time all of the test meal protein had left the stomach. Reasons are given for the assumption that all of the test meal protein, or an equiv. mixt. of dietary and endogenous protein, was absorbed in this period of time. The results indicate that ingested protein is mixed in the lumen of the digestive tract with relatively large amts. of endogenous protein which originate in the digestive tract itself.

Peptide digestion by intestinal mucosa.

SHAW, B. AND ROBINSON, G. B. (Dept. of Med. Biochem., Med. School, Birmingham, Engl.). *Intern. Congr. Biochem. 4*, 155 (1958).

The digestion of synthetic and naturally occurring peptides by intestinal mucosal exts. from rat and hog has been studied. Using synthetic peptides the distribution of peptidase activity along the rat intestinal tract is under consideration. With glycylglycine and L-leucylglycine it has been shown that the concn. of glycylglycine dipeptidase and leucine amino-peptidase increases along the intestine from duodenum to ileum. The sequence of amino acid release and the desamidase activity of exts. of hog and rat intestinal mucosa have been studied using the peptides occurring in a peptic-tryptic digest of gluten.

The inhibition of the intestinal absorption of an amino acid by chlortetracycline.

AGAR, W. T. AND PARKER, M. A. (Dept. of Physiol., Univ. of Melbourne, Australia). *Biochim. et Biophys. Acta 30*, 243–6 (1958).

The presence of chlortetracycline in a loop of intestine in the living rat reduced the absorption of L-histidine to 71% of the control figure. This effect was produced by an amt. of chlortetracycline comparable, weight for weight, with a therapeutic dose in man.

ENGINEERING RESEARCH

The manufacture of chemical cellulose from wood.

WAYMAN, M. (Columbia Cellulose Co., Prince Rupert, British Columbia). *Can. J. Chem. Eng. 36*, 271–6 (1958).

This paper discusses progress made and problems assocd. with the manuf. of chemically pure cellulose from wood. The yield of pure cellulose which can be obtained from any wood species is limited by the chem. compn. of the wood starting material. Conditions are developed for the most effective way of carrying out extn. of raw pulp with hot caustic soda. These include very high consistencies and very short times at high temps. The best conditions for extn. with strong caustic soda at low temp. are also reviewed. The need for properly designed equipment for both these processes is stressed. The special problem of removal of mannan is discussed.

FOOD AND FOOD TECHNOLOGY

Antioxidants

Some nutritional and allied problems confronting the food manufacturer: technological aspects of antioxidants.

LEA, C. H. (Univ. of Cambridge, Engl.). *J. Sci. Food Agr. 9*, 621–32 (1958).

A comprehensive review of the chemical and practical aspects of substances used to retard oxidative deterioration in food with particular emphasis on the effectiveness of certain compds. in a number of foodstuffs, e.g. fats and oils, bakery products, dairy products, fish meals.

Cereals and Grains

Effect of alkali treatment on the availability of niacin in maize.

HARPER, A. E., PUNEKAR, B. D. AND ELVEHJEM, C. A. (Dept. of Biochem., Univ. of Wisconsin, Madison). *J. Nutrition 66*, 163–72 (1958).

In confirmation of the results of other workers, it has been demonstrated that rats receiving a niacin-deficient diet in which untreated maize is replaced by alkali (NaOH or CaO)-treated maize, do not develop signs of niacin deficiency.

The distribution of amino acids in wheat and certain wheat products.

HORN, M. J., FIFIELD, C. C., BLUM, A. E. AND WARREN, H. W. (Agr. Research Service, Washington, D. C.). *Cereal Chem. 35*, 411–21 (1958).

Eleven amino acids of whole wheat were quantitatively accounted for when the extn. products, flour, bran, and shorts were assayed by microbiol. procedures. No destruction of amino acids occurred during fermentation of the doughs prior to baking into bread. Losses of cystine, lysine, and methionine during baking were significant. Most of these amino acid losses may have taken place in the crusts.

New rice mutant.

ANON. *Rice J. 61*, 21 (Dec. 1958).

A new early-maturing rice mutant with possibilities for breeding new varieties was created through atomic radiation, in cooperative research by USDA and the Louisiana Agr. Expt. Sta. They produced a mutant that matures 4 or 5 weeks earlier than Rexoro. Other early varieties with the high quality of Rexoro may be bred from crosses of the new strain with com. rice.

Gelatin and Gums

Properties of thiolated gelatins.

BENESCH, R. E. AND BENESCH, R. (Marine Biol. Lab., Woods Hole, Mass.). *Intern. Congr. Biochem. 4*, 23 (1958).

The amino groups of gelatin can be substituted with *n*-acetylhomocysteinyl residues through the formation of new peptide bonds. In this way gelatins containing up to 30 sulfhydryl groups/100,000 g. have been prepd. These proteins have lower isoelec. points (up to 2 pH units) than the parent proteins. They still form reversible gels with somewhat lower melting points. Oxidation with ferricyanide at pH 7 gives 2 very different disulfide forms according to conditions.

Legislation

Establishing tolerances for food additives.

RANKIN, W. B. *Food Drug Cosmetic Law J. 13*, 641–8 (1958).

Included in this discussion of the new food additives law are such topics as type of testing required, types of substances subject and not subject to the law, and the action taken by the Dept. of Health, Education and Welfare in approving a particular additive.

Some public health aspects of food and beverage vending.

ANSON. *J. Milk & Food Technol. 21*, 350–2 (1958).

The specific requirements for the protection of readily perishable hot and cold foods in vending machines is discussed with regard to storage temp., container design and machine construction, together with pertinent quotations from the Ordinance and Code covering the Vending of Foods and Beverages Recommended by the Public Health Service. The problem of copper poisoning from copper tubing in carbonated beverage machines is also discussed.

Meat and Fish

Some properties of a new structural protein of muscle.

TSAO, T. C., PAN, C. H. AND TAN, P. H. (Inst. of Biochem., Academia Sinica, Shanghai, China). *Intern. Congr. Biochem. 4*, 83 (1958).

A new, globular and water-sol. protein of I. P. ~ 4.9 has been isolated from skeletal, cardiac and visceral muscles. It can be prepd. easily from myofibrils of rabbit skeletal muscle by extn. with a molar citrate buffer, pH 5.1, followed by $(NH_4)_2SO_4$ fractionation. The protein is devoid of N-terminal amino groups and appears to be composed of a looped polypeptide chain ending in –Ala. Tyr. Leu. at the carboxyl end. The combined chem. and physico-chem. data suggest that it is an entity quite distinct from the well-known myofibrillar proteins-actin, tropomyosin and myosin, and from the new structural proteins reported in literature, such as Y- protein, contractin, Δ-protein, extra protein and pseudoglobulins.

Milk and Milk Products

Significance of strontium-90 milk. A review.

LARSON, B. L. AND EBNER, K. E. (Dept. of Dairy Sci., Univ. of Illinois, Urbana). *J. Dairy Sci. 41*, 1647–62 (1958).

Current and projected levels of Sr-90 in milk should not cause concern when compared to radiation received from national sources; but farther studies are necessary.

Mechanization in the cheese industry.

WEARMOUTH, W. G. (Natl. Inst. for Research in Dairying, Shinfield, Engl.). *Food Manuf. 33*, 496–500 (1958).

Recent improvements in factory cheesemaking are reviewed. Also discussed are studies on ripening: i.e. acceleration of ripening time by irradiation, and improvement of ripening by use of polymer films. Other topics covered are bacteriophage, new cheesemaking machines, and the continuous cheesemaking process.

Heterogeneity of crystalline rennin.

ERNSTROM, C. A. (Dept. of Dairy and Food Inds., Univ. of Wisconsin, Madison). *J. Dairy Sci. 41*, 1663–70 (1958).

Block-shaped crystals were prepd. from a coned. soln. of purified rennin by dialyzing it against Berridge's salting-in buffer. The purification procedure was relatively simple, and proved successful in each of several attempts to obtain rennin pure enough to crystallize. A single boundary in electrophoresis represented over 96% of the protein when the dissolved crystals were run at pH 6.8 in sodium phosphate buffer at an ionic strength of 0.2. However, at least 4 components were evident in the same buffer at 0.033 ionic strength. These results show that rennin prepns. can not be considered homogeneous on the basis of their cryst. form or their electrophoretic behavior in phosphate buffers of high ionic strength.

Nuts

Bitter principles of the peanut. Isolation, general properties and distribution in the seed.

DIECKERT, J. W. AND MORRIS, N. J. (U. S. Dept. of Agr., New Orleans, La.). *J. Agr. Food Chem. 6*, 930–3 (1958).

A concentrate of the bitter principles of peanut hearts has been prepd., which possesses the general properties of the saponins. Glass paper chromatography indicates at least 4 components, each stained reddish purple with coned. H_2SO_4 and altered by acid hydrolysis. Aglycones obtained by acid hydrolysis can be sepd. into at least 6 components by chromatography on glass paper treated with monopotassium phosphate. Each gives a reddish purple color with H_2SO_4. The sugar moiety from the hydrolytic cleavage products gives 4 spots when chromatographed. These spots correspond in R_f value and color to glucose, xylose, rhamnose, glucuronolactone.

Pectin

Reaction of hydroxylamine with pectinic acids. Chemical studies and histochemical estimation of the degree of esterification of pectic substances in fruit.

GEE, M., REEVE, R. M. AND MCCREADY, R. M. (Agr. Research Service, Albany, Calif.). *J. Agr. Food Chem. 7*, 34–8 (1959).

The reaction of the carbomethoxyls of pectinic acids with hydroxylamine in aq. alc. solns. was studied. The rate and extent of formation of pectin hydroxamic acid were followed by developing the colored spots of the ferric-pectin hydroxamic complex on filter paper strips and measuring the reflection densities. These series of reactions were applied to measure the degree of esterification of pectic substances in fruit tissue sections. This procedure introduces a new direct method for following the esterification of pectic substances in fruits at different stages of their development.

Potatoes

North American potato varieties.

DARLING, H. M. *Potato Handbook* (1959).

Proper identity of the many potato varieties being grown particularly for seed purposes in North America today is becoming an increasingly complex one. At the present time there is no single publication available for reference in which all of our present varieties are described. The variety picture is constantly changing and will continue to change because several breeding programs are currently releasing varieties superior in at least one characteristic to our present standard varieties. A summary description of the present varieties is given.

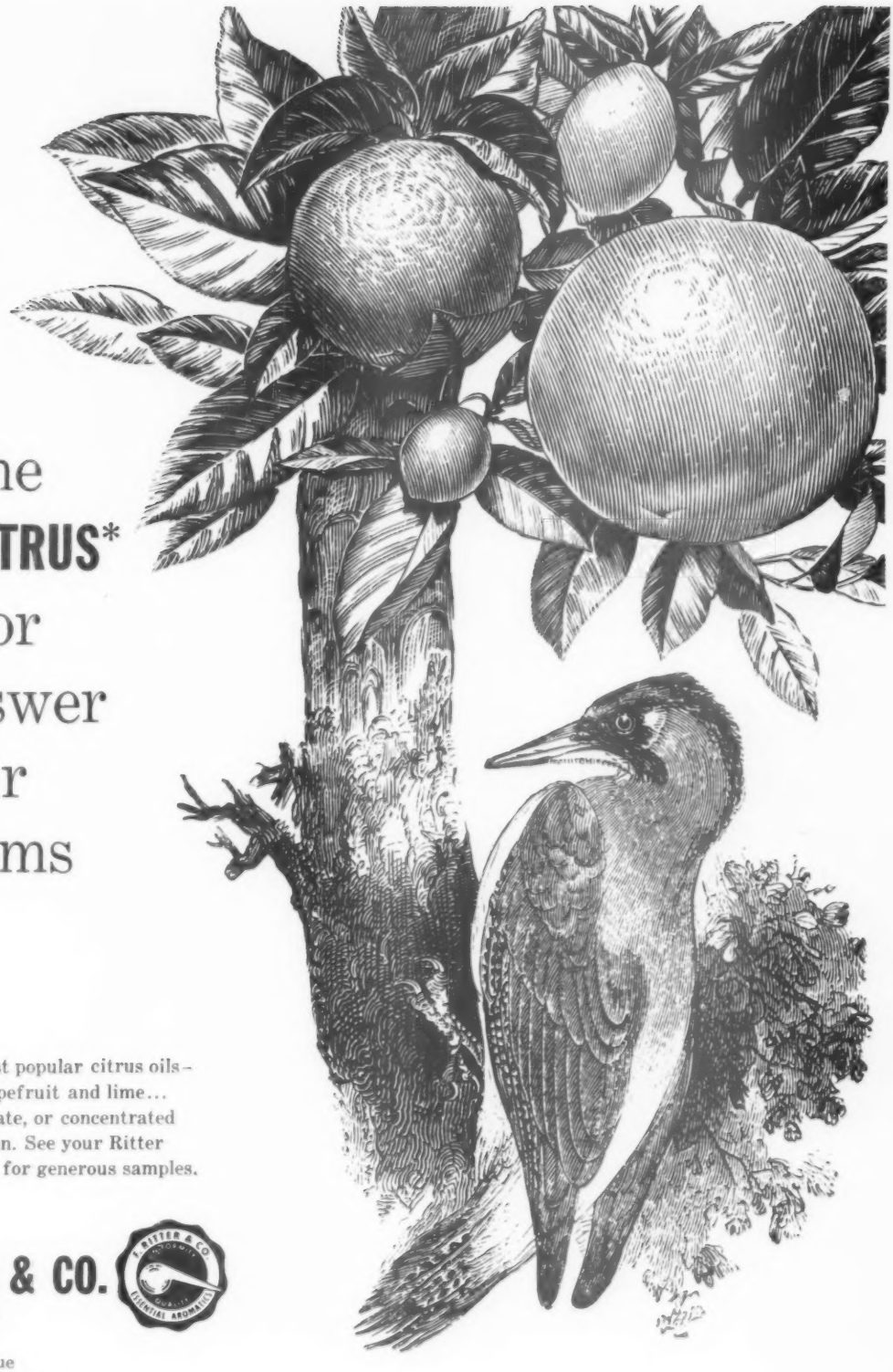
Specific gravity of different zones within potato tubers.

SHARMA, M. K., ISLEIB, D. R. AND DEXTER, S. T. (Michigan State Univ., East Lansing). *Am. Potato J. 35*, 784–8 (1958).

In varieties where the specific gravity of the entire tuber was high there was a large difference in specific gravity between pith and the two outer zones. There was generally little difference in specific gravity between the two inner zones. The specific gravity of the innermost zone (pith) was relatively uniform between varieties.

Starch

Characteristics of corn starch and starch derivatives as affected by freezing, storage, and thawing.



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ALBRECHT, J. J. (Univ. of Illinois, Urbana). *Dissertation Abstr. 19*, 1049–50 (1958).

The effect of phys. variables, such as rate of freezing, storage time and temp., shearing of granule systems, and heat treatment prior to freezing, were detd. in order to produce a white sauce system which would be stable to freezing and subsequent thawing. It was found that enzyme susceptibility was not a suitable criterion for retrogradation in white sauces.

Synthesis of amylose by potato D-enzyme.

WALKER, G. J. AND WHELAN, W. J. (Lister Inst. of Preventive Med., London, Engl.). *Nature 183*, 46 (1959).

The synthesis of an amylose-like material by another enzyme system, the D-enzyme is reported. This system catalyzes the reversible disproportionation of maltodextrins, the glucose oligosaccharides contg. the α-1:4 linkage. If the potato is equipped with a glucose removing enzyme system in addn. to D-enzyme, it is presumably capable of synthesizing amylose by a route other than that provided by phosphorylase. It is suggested that the potato may use both the phosphorylase and D-enzyme to synthesize amylose, the product from phosphorylase remaining as amylose and that from D-enzyme being converted into amylopectin by Q-enzyme.

A multi-enzyme system for the concurrent synthesis of amylose and amylopectin.

WHELAN, W. J. AND WALKER, G. J. (Lister Inst. of Preventive Medicine, London, Engl.). *Intern. Congr. Biochem. 4*, 46 (1958).

It has been suggested that amylose and amylopectin may be synthesized from a common maltodextrin substrate in compartments sepd. by a membrane permeable to maltodextrins, but not to enzymes and polysaccharides. The stages in the synthesis are given.

Taste Testing

The effect of age on taste sensitivity.

COOPER, R. M., BILACH, I. AND ZUBEK, J. P. (Dept. of Psychol., Univ. of Manitoba, Winnipeg, Can.). *J. Gerontol. 14*, 56–8 (1959).

A sipping technique was used to test 100 subjects, aged 15 to 89, for taste sensitivity to substances of a sweet, sour, salty, and bitter nature. It was found that the curve of development and decline for sensitivity to each of the 4 taste primaries was essentially the same. All curves showed a noticeable decline after the late fifties. No sex differences were observed nor were there any differences in taste sensitivity between smokers and non-smokers.

Current techniques of odor measurement.

NADER, J. S. *Arch. Ind. Health 17*, 537–41 (1958).

Proper evaluation of odor on the basis of its definition requires both a measurement of odorant concn. and a measurement of human response. Instruments are devised to provide known and controlled concns. of odorants. There are currently in use several representative types of odor app. which vary from the simple syringe technique for threshold diln. ratio measurements to the precise and versatile odor evaluation app. for field and laboratory use. Data resulting from odor measurements are randomly distributed for a population of subjects and require statistical evaluation.

RADIOCHEMICAL TECHNOLOGY

Synthesis of products of higher molecular weight in radiolysis of aqueous solutions of formic acid.

GARRISON, W. M., BENNETT, W. AND COLE, S. (Crocker Lab., Berkeley, Calif.). *Radiation Research 9*, 647–59 (1958).

Irradiation of dilute, oxygen-free formic acid solns. with cyclotron-produced protons or helium ions leads to the synthesis of a number of products of higher mol. wt. The compds. identified include oxalic, glyoxylic, glycolic, mesoxalic, tartronic, and tartaric acid, and glyoxal. These products are not formed in appreciable yield by neutron (and γ-ray) irradiation. The observations are correlated in terms of a reaction mechanism that involves dose rate-dependent steps.

Industry

New Laboratories, New Testing Kitchen for Flavor Development Work at Givaudan

The importance of flavor in the foods we eat cannot be over-estimated. Flavor is by far the most important factor in the selection of foods as well as in its consumption. Poorly flavored foods cannot be eaten in any quantity nor can they be digested properly. A well-flavored morsel will tickle the eater's appetite and make him crave for more, but a poorly flavored one will be discarded after the first taste.

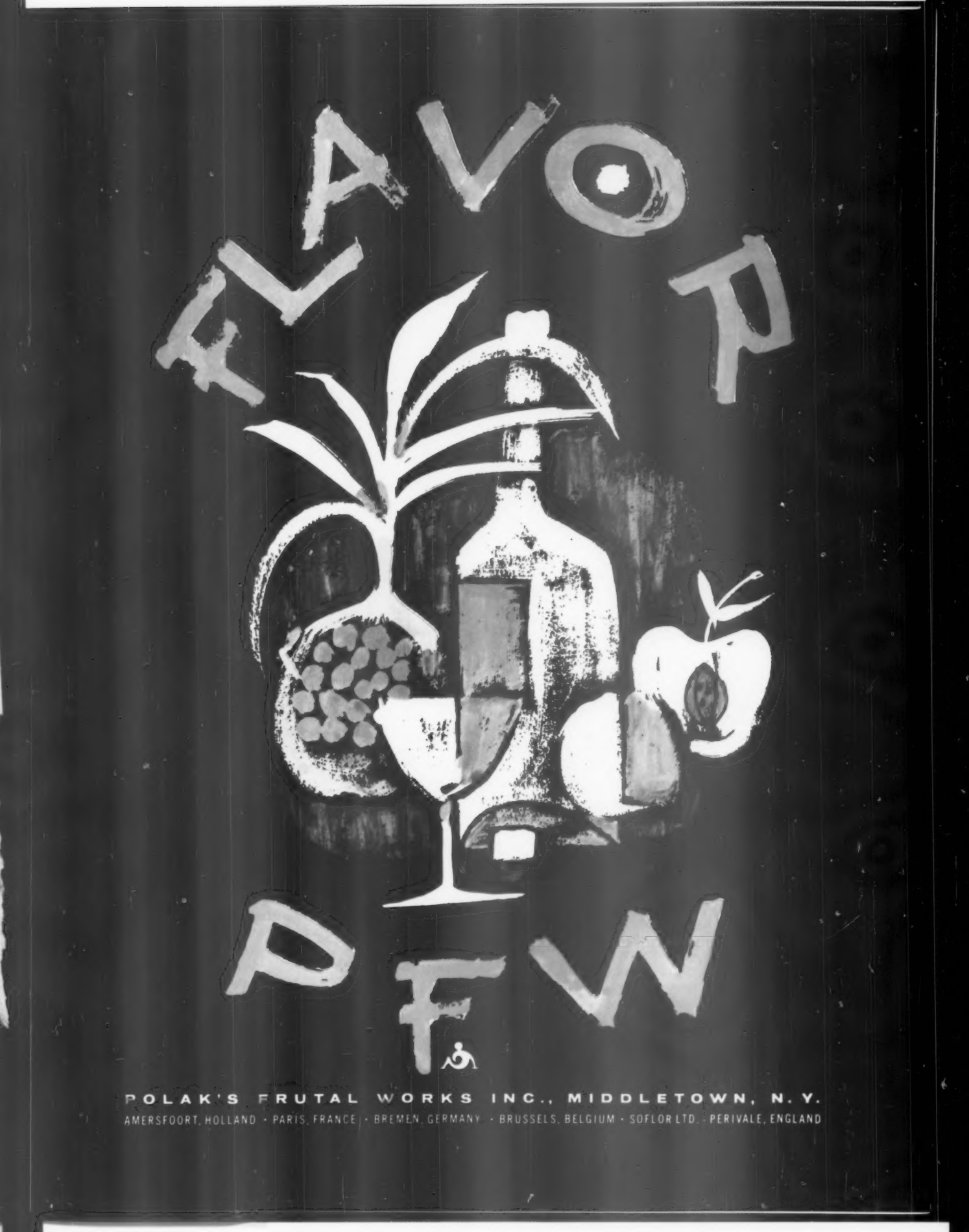
This well-defined position of taste in today's living makes it more essential that flavors be created that would not only be chemically compatible with the foods in which they will be used, but be acceptable taste-wise to the consumer. With this basic concept in mind, the new flavor laboratories and testing kitchen of Givaudan Flavors Inc., New York, were designed.

The creation of a new flavor or the adaptation of a well-known one to a new use is the task of the flavorist—a chemist trained not only in organic chemistry but in the art of creating taste sensations. Whether it be the recreation of a flavor of natural fruits or a completely new concept in taste, the flavorist—with his highly trained taste buds and sense of smell—combines individual ingredients, both natural and synthetic, to achieve the final flavor composition. Here, at Givaudan, he has available all the natural and synthetic chemicals in use today for flavor creation. He has also the most modern, specially air conditioned, laboratory facilities in which to work. The electronic balance which he uses is accurate to a fraction of a gram and the atmosphere around him is odor- and dust-free.

From the hands of the flavorist, his creation goes to the testing kitchen which would be the envy of any housewife. The home economist prepares the various foodstuffs such as candies, baked goods and others, in which the flavor can be evaluated. Taste panels consisting of technical, non-technical and consumer panelists evaluate the effectiveness of the flavor in the finished media and their judgment is of vital importance in the final selection.

If the flavor is designed specifically for a food to be pressure-packaged, it is submitted to the Aerosol Laboratory for complete evaluation and testing. This laboratory has all types of sealing and filling devices and uses every known type of propellant, container and valve. The filled aerosol is subjected to many tests to ascertain the compatibility of the individual ingredients as well as the acceptibility of the product as a whole.

Thus, a newly created or adapted flavor moves through the various stages of its development in the Givaudan laboratories. When it is finally submitted to the user, he can be sure that it is exactly suited to the use he has in mind and fits exactly the taste specified.



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Marine Colloids, Inc. to Specialize in Carrageenates and Alginates

Of interest to food processors was the recent merger of Algin Corporation of America and Seaplant Corporation, forming a new company under the name of Marine Colloids, Inc., with executive offices at 24 State Street, New York.

Production will continue as usual at Algin Corporation's Rockland, Main plant and at Seaplant Corporation's New Bedford, Mass. plant. No change is contemplated in either the names or character of any of the products made by either organization.

Mr. C. E. Lichtenauer, heretofore President of Algin Corporation of America, is the President of the new organization; Mr. Earl C. Jertson, former President of Seaplant Corporation, will be affiliated with the new company as Director and Special Consultant; Mr. J. R. Moss, formerly of Kelco Company, will be Vice-President in Charge of Sales and Development, with offices in New York. Research and Production will be headed by Mr. V. C. LeGloahec and Mr. B. J. Pellicani respectively, with offices in Rockland, Maine.

The new organization will specialize in the production of Irish Moss Extracts (Carrageenates) and Alginates. Irish Moss Extracts are widely used as a stabilizing ingredient in blended ice cream stabilizers, for suspension of chocolate in chocolate milk, as a gelling agent in dessert type foods, for bodying and thickening of fillings and toppings, and as a stabilizer in icings and meringues. Alginates also have broad uses as emulsifying stabilizers, gelling agents, thickeners and stabilizers.

Due to the enlarged research and production facilities, Marine Colloids, Inc. expects to produce a greater variety of Carrageenates and Alginates which will have a wider range of uses than has been possible to obtain in the past. The merged Sales Department of the new organization will be composed of highly trained technical representatives who will be able to assist customers and friends in the use of the company's various products, especially towards the development of new end use applications.

Tin Can Industry to Observe 150th Birthday in 1960

The metal can industry, the nation's largest supplier of rigid containers, is planning to celebrate in 1960 the 150th anniversary of the invention of the can, the Can Manufacturers Institute has announced.

The official basic theme and slogan for the commemorative year will be "Metal Cans—Serving Man for 150 Years," according to the Institute.

Roger F. Hepenstal, newly-elected president of the Institute, revealed the industry's plans to observe 1960 as the sesquicentennial of the can following a special committee meeting recently at a mid-town New York City hotel.

Industries and companies who are principal users of cans are expected to join in the observance, Hepenstal declared, pointing out that the food processing industry buys more than 50 per cent of all cans produced and the brewery industry uses another 20 per cent. Other heavy consumers of cans are the oil, coffee and pet food industries, he said.

"Today's familiar tin can is the direct descendant, so to speak, of the one patented by an inventive 19th century Englishman," Hepenstal said. "This man was Peter Durand, a merchant of Hexton Square, Middlesex Shire, and on August 25, 1810, he was granted a patent by King George III for preserving foods in various containers, including those made of tin.

"Durand called these containers 'tin canisters,'" Hepenstal added, "but when can-making was introduced in America in 1839 the early Yankees quickly trimmed that down to 'tin can.'"

Actually, the term "tin can" is a misnomer, the CMI president pointed out. Despite millions of tons of metal, mostly steel, going into cans each year, only from 2 per cent to 4/10ths of one per cent is tin. And millions of cans produced annually have no tin at all, he edded.

"Of course, modern adaptations of the metal can have gone far beyond its original use by Durand," Hepenstal continued. "Hundreds of non-food products now are marketed in cans and have helped swell the industry's production total last year to approximately 42 billion cans for all purposes. Due to this heavy output, the metal can industry is now the third largest user of fabricated steel in the U. S., exceeded only by the automobile and construction industries."

Hepenstal said the industry planned to mark the can sesquicentennial on the local, state and national levels during 1960 with its principal suppliers and customers being invited to participate in the observance.

Because of the worldwide manufacture and use of the metal can and its economic importance as a packaging medium, the CMI president added that it was expected that foreign can makers and their suppliers and customers also would join in observing the 1960 milestone.

Research Today For Tomorrow

"Marketing, to an important degree, deals with new products. You cannot have new products without research," stated C. H. Koonz, Swift & Co. Research Laboratories, at the American Poultry Industries' 30th Fact Finding Conference in Kansas City, Mo.

"We must do the research today for tomorrow—or some competitive agricultural commodity will take part of our business. We are being pushed right now by the swine industry, which took a lesson from our book. Today, using 2.2 pounds of feed at 4½ cents a pound, we are producing a pound of broiler meat with 10 cents worth of feed. Using 3.2 pounds of feed at 3½ cents a pound, the swine industry can now produce a pound of pork with 11.2 cents worth of feed. So they are rapidly catching up with us.

"At the same time they are also emphasizing the production of leaner hogs, disease control, year around supply, aggressive merchandising, and an educational program to sell consumers on the nutritional value of lean pork.

"The poultry industry will continue to do all right, competitively, only if we prepare today for tomorrow — through research. Research must not be considered an unnecessary expense. It is a sound investiment. It must be productive —and geared to business."

Cause for a Pause for Thought

From the Nutrition Foundation's *Nutrition Items:*

Five Major Factors Contributing to Heart Attacks, according to latest report by top nutritionists and physicians, are: Heredity, Overweight, High Blood Pressure, High Cholesterol Level in Blood, and Excessive Cigarette Smoking.

Income Has Little To Do With Poor Nutrition, says Dr. C. G. King of the Nutrition Foundation, who notes that a lack of protein and a lack of education are major causes of poor nutrition, which is common among the wealthy and poor.

You, Too, Can Spot a Quack "Salesman"—Beware: if he calls himself "a medical expert" and uses a secret machine or formula; if he guarantees a quick cure or recovery; if he claims he is being persecuted by medical men or government agencies; if he tells you that surgery, x-rays or drugs cause more harm than good; if he uses case histories and testimonials of unknown persons to promote his "cure"; and if he clamors for medical recognition and investigation.

Overdose of Vitamins Can Be Harmful—So reports the American Medical Association in an analysis noting that vitamins soluble in *water* beyond the body's needs are excreted and wasted, but that vitamins soluble in *fat* (such as vitamins A and D) can accumulate and cause injuries if taken in excess. Daily limit of vitamins A and D intake for normal persons is about 5,000 units of A and 400 units of D. Good diets furnish these quantities.

Did You Know (As Seen from the Vantage Point of Nutrition):

—that salt is not fattening, but serves to retain fluids in the body?

—that vegetable juices have no more (usually much less) nutri-

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in Improved Particle Control
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and mustard
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Dispersion of fruit pulp
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Why not investigate Gaulin Homogenizers, Sub-Micron Dispersers or Colloid Mills for your products? Send for Technical Bulletins H-55, LH-55, SMD-55 and C-57. Ask for Gaulin GTA . . . Gaulin Technical Assistance, too. Or if you prefer to try Particle Control in your plant, rent a Gaulin Laboratory Homogenizer or Colloid Mill for only $75.00 per month.

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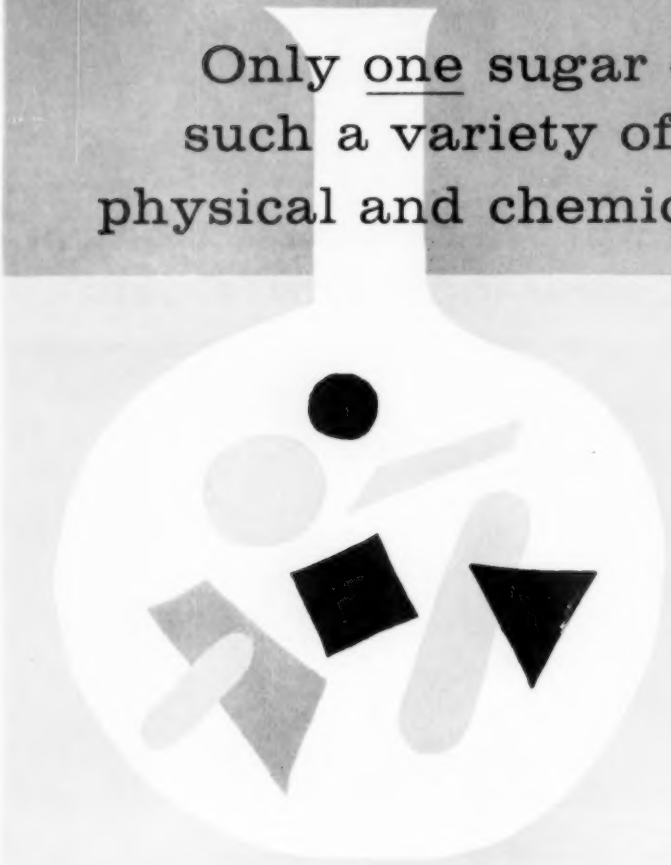

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Lactose can improve your present products . . . help you develop new ones. Lactose can simplify your processing. Lactose can lower your costs. Seldom do you find such a versatile material.

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Only Western can supply Lactose, Edible, in the full range of particle sizes required by various food applications. Strict chemical and bacteriological specifications, rigid quality control and years of processing experience assure highest quality.

Take a fresh look at the characteristics of Lactose. One of them may help solve a problem you are working on right now. For free samples and information, *write our Technical Service, Department 24E. (Tell us the applications you are considering.)*

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tional value than the vegetables from which they are made?

—that the vitamin content in foods which are canned or frozen is mostly retained?

—that chemicals used in processed foods are rigidly pre-tested for safety?

—that prolonged cooking of food tends to lower nutritive value?

—that frozen green peas taste best when cooked only about 2-to-3 minutes at boiling?

—that after reaching the "proper weight level" at 25 years of age, your intake of food should be decreased by 10% each year to age 55 to maintain this "proper weight"?

"Eighteen Calories per Level Teaspoonful"

The familiar "18 calories in a level teaspoonful of sugar" message from Sugar Information's advertisements is being featured on one million Delson Merri-Mint boxes beginning this month, Armin Schaper, Sales Manager of Delson Candy Company announced.

Delson is including the calorie message with its picture of a sugar bowl and spoon, which has appeared in every Sugar Information advertisement since its advertising campaign began more than five years ago, because it believes the sales' fortunes of sugar and candy are closely related, Mr. Schaper said. Specially prepared copy on the boxes containing Delson's all-sugar mints points out: "Candy helps supply today's bigger need for energy. Our new active living calls for extra quick energy. Easiest way to get it is sugar, principal ingredient in candy. No other food converts so quickly and thoroughly to energy."

"Delson is proud to be the first candy company to use this effective calorie message about sugar. We believe it is a strong selling point not only for sugar, but for candy," Mr. Schaper said.

"Sugar Information has long been carrying the battle not only for sugar, but also for candy and other foods containing sugar. It has done an effective job to counteract misinformation, and to refute the propaganda of food faddists and others who blame sugar, candy and other sweet foods for all dietary ills. We at Delson feel it is time for the candy industry to get off the defensive and take the same positive approach in selling its product. We firmly believe that a successful candy company must point out the many fine nutritional benefits — and the sincere enjoyment—people receive from eating candy. Including the sugar calorie and energy message helps us do this," Mr. Schaper said.

"We are happy to make our 18 calorie message available to the Delson Candy Company," Robert D. Goodwin, Coordinator of Advertising and Public Relations for Sugar Information said. "We are always ready to cooperate with food industries such as candy which use sugar in their fine products. We hope that this will be but the first step in an increased cooperation between our two industries," he added.

New Method for Evaluating Color

The American Spice Trade Association has developed a new method for evaluating the color and quality of paprika. It is the first to be released of a series of new standardized procedures for determining quality in spices.

The paprika analysis consists of extracting the color from the spice under carefully controlled conditions and measuring absorbance of the solution at a fixed wave length with a spectrophotometer. The resulting value is then compared with the absorbance of a readily reproducible inorganic standard.

A new A.S.T.A. color unit has been defined and the values are relatively small and easily comprehensible. At present, the new paprika method is listed as tentative since it has not had a wide scale tryout by the industry. After approximately a year's use, it will be reviewed and, in all probability, will be made official.

There are a number of methods that have been used to evaluate the color of paprika and the various capsicum spices. Some of them rely on visual color matching by the operator and give values that are up in the thousands. Normally, the new A.S.T.A. color units will range between 100 and 200.

The new procedures for analyzing the quality of spices are expected to gain wide attention in the food processing field, as an aid to manufacturers in controlling their purchasing and production. They are improvements over the present analytical methods for spices. The project was carried out by the spice association's Research Commitee in cooperaion with the U. S. Department of Agriculture's Agricultural Research Service.

Copies of the paprika color evaluation method are available from the American Spice Trade Association, 82 Wall Street, New York 5. Procedures for other spices will be released in the near future.

EQUIPMENT

IT'S KOROSEAL FOR KERNELS. Shelled walnuts at Diamond Walnut Growers, Inc., plant in Stockton, Calif., glide from storage bin to grading tables on thousands of feet of smooth, easy-to-clean Koroseal food handling belts. The belts, made by B. F. Goodrich Industrial Products Company, Akron, Ohio, resist vegetable, animal or mineral oils or greases. Tan, non-porous covers cut costs by reducing cleaning time previously required for plastic-coated cotton belt used here. Koroseal belt shown above is 70 feet long and 16 inches wide, operates 10 hours a day, 10 months of the year, carries 8,000 pounds of shelled walnuts an hour. In service six months, the belt shows no sign of wear, has required no maintenance or repair. A series of "eye rest" green Koroseal belts, 42 inches wide and 10 feet long, act as moving tables or inspection belts for the final grading of the walnuts.

PERSONNEL

Dr. C. G. Harrel, former Director of the New Product Ideas Department of Pillsbury Mills, Inc. has established an office at 3424 East Lake St., Minneapolis, Minnesota, where he will engage in consultancy work for baked products and other branches of the food industry. "Doc" Harrel has had many years of experience in directing quality control and research projects on flour, mixes, baked products, and during recent years, on new food products for the American consumer.

On March 31, 1959, Doc Harrel received the U. S. Army's Certificate of Achievement for his services, dating back to 1940, on behalf of improved rations for the Armed Forces. The award was presented by Major General Andrew McNamara, the Quartermaster General, on the occasion of the Research and Development Associates' annual meeting in Washington, D. C.

Dr. James W. Evans, director of Hammond, Indiana Research Laboratories of American Maize-Products Company, has been elected vice president in charge of research, President Theodore Sander, Jr. announced following the company's board meetting in New York. Dr. Evans, a native of Chilhowee, Missouri, obtained his basic education in Missouri and his doctorate at the University of Minnesota in 1940. He is a recognized leader in the fields of agricultural and food biochemistry. He began his industrial career in 1930 with Union Starch and Refining Company, Granite City, Illinois, leaving for three years to obtain his doctorate, during which he was an instructor at Minnesota. In 1943 he became head of the food and carbohydrate research section of General Mills' Laboratories in Minneapolis. On April 1, 1950 he was named director of research of American Maize-Products Company.

Dr. Lloyd B. Jensen, Chief Bacteriologist, retired, of Swift and Company received the Pasteur Award of the Society of Illinois Bacteriologists on April 11, at ceremonies held in the Constitution Room, Morrison Hotel, Chicago. The title of Dr. Jensen's Pasteur Award Lecture was "Classical Food Borne Epidemics of the World."

Mr. Arch Payne has been elected Assistant Vice-President of Florasynth Laboratories, Inc., internationally known manufacturers of basic materials for the food, drug and cosmetic industries with executive offices in New York City. He is a veteran of over thirty years in this field and has been General Sales Manager of Florasynth Laboratories since 1947, a position which he will retain along with his new duties and responsibilities.

Arch Payne

The Board of Directors of Chain Belt Company has appointed **G. K. Viall** as Senior Vice President of the Company. A native of Ohio, Viall joined Chain Belt in 1921 as an engineer in their Construction Machinery Division. He served as Chief Engineer of the Chain Division; Assistant to the President; Works Manager; and Vice President. He established the firm's Planning Department which became the nucleus of the present Methods Department; and the Company's Research and Development Section.

G. K. Viall

The Nestlé Company, Inc., today announced the appointment of **Hatton B. Rogers** as manager of product development for its bulk and institutional division. Mr. Rogers will work from the Nestlé headquarters, White Plains, N. Y. For the past five years, Mr. Rogers has been vice president of Dodge and Olcott Inc. He was previously director of technical services for Huron Milling Co. and director of research and quality control for Phillips Packing Co. prior to that.

F. A. Baldauski

Appointment of **Francis A. Baldauski,** a graduate chemist, as technical sales representative in the metropolitan New York City area for Sterwin Chemicals Inc., was announced by William X. Clark, vice-president in charge of sales. Mr. Baldauski will concentrate on the food industry in Westchester County, Long Island and parts of New Jersey, as well as New York City.

One of the nation's outstanding research leaders in food processing, **Dr. Roy C. Newton,** will retire April 1 as Swift & Company's vice-president in charge of research. Dr. Newton, a past president of IFT, has received many scientific honors: the Gold Medal of the American Institute of Chemists (1957), the Award of the Industrial Research Institute, and the Nicholas Appert award of IFT, to name but a few.

R. C. Newton

In his 35 years as a Swift scientist, 18 of them as vice-president of research, Dr. Newton has helped build a research staff that has contributed hundreds of improved forms of food and food products. His personal research, especially in the field of stabilization of edible fats and oils, has contributed many valuable processes to the industry. Under his direction, Swift nutrition fellowships and grants-in-aid for basic research in agriculture have been extended to universities and colleges.

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Title 21—FOOD AND DRUGS
Chapter I—Food and Drug Administration, Department of Health, Education, and Welfare
SUBCHAPTER B—FOOD AND FOOD PRODUCTS
PART 17—BAKERY PRODUCTS; DEFINITIONS AND STANDARDS OF IDENTITY
Addition of Wheat Gluten To List of Optional Ingredients

Vicrum is now Permitted in Rolls and Buns

This amendment to the Bread Standards, which became effective April 5, 1959, permits the use of Vicrum (Hercules Vital Wheat Gluten) in rolls and buns, enriched rolls and buns, raisin bread, raisin rolls and buns. The amendment limits the use of Vicrum not to exceed up to 4 parts of wheat gluten for each 100 parts by weight of flour.

A NEW AID FOR BAKERS

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Dr. Newton, a native of El Reno, Oklahoma, was a student at Oklahoma A & M College (now Oklahoma State University) when he enlisted in the Army during World War I. He won the Croix de Guerre with Star for meritorious service with the Second Division in France. After his army discharge he returned to Oklahoma A & M and received his bachelor's degree in chemical engineering in 1921. He taught in the chemistry departments of Oklahoma State, Purdue and Lewis Institute before joining Swift's research department in 1924. He received his doctorate in chemistry from the University of Chicago the same year. Dr. Newton also holds a D.Sc. (honorary) from Purdue.

Dr. Newton will direct his attention to food production, i.e., to raising beef cattle on his farm near Three Rivers, Michigan.

Harry J. Conover has been appointed a sales territory representative for the Canning Machinery Division's Eastern Operation in Hoopeston, Illinois, it was announced recently by Food Machinery and Chemical Corporation. Conover will handle sales of canning and processing equipment in the Southeastern territory which embraces the states of North and South Carolina, Georgia, Alabama and Tennessee. Conover joins the FMC organization with a wide knowledge of the food canning and food processing industry. He is a graduate of the National Agricultural College, Doylestown, Pennsylvania, where he earned a Bachelor of Science degree in horticulture. His past experience includes 1½ years as Grain Inspection Supervisor, U. S. Department of Agriculture, Baltimore, Maryland, and two years of research and development work on precooked, dehydrated foods and irradiated food while on active duty with the U. S. Army in the Quartermaster Food and Container Institute in Chicago. Previous to this, Conover had six years of experience in fruit and vegetable production in southern New Jersey.

H. J. Conover

Dr. H. E. Robinson, Swift & Company's director of laboratories, was recently made vice president in charge of the company's scientific research activities at the monthly meeting of the Board of Directors. He succeeds Dr. R. C. Newton, who retires April 1.

H. E. Robinson

Dr. Robinson joined the Swift research staff in 1932. He was named assistant director of research in 1941, assistant director of laboratories in 1950, and director of laboratories in 1953. He received his bachelor's degree in chemistry at the University of Montana in 1927 and his doctor's degree in food chemistry at the University of Pittsburgh in 1931. He also is a graduate of Harvard University's advanced management program.

Swift's new research vice president has been prominently identified with industry and government research projects in the field of nutrition. Currently he is a member of the food industries advisory committee of the Nutrition Foundation, member of the research advisory committee to the Secretary of Defense, and member of the organizing committee for the International Nutrition Congress to be held in the United States in 1960, and member of the research committee, National Association of Manufacturers.

His company research activities have been associated with glycerides, B-complex vitamins, poultry nutrition, canine nutrition, animal feeds, fats and oils, and the effect of processing on nutritive values of foods.

Among the professional honors presented to Dr. Robinson is the Award of Merit in 1958 by the Chicago Technical Societies Council. He is a member of the American Chemical Society (past president of the Chicago section); Chicago Chemists Club, past president; American Oil Chemists Society, Poultry Science Association, Institute of Food Technologists and the Industrial Research Institute.

Two appointments on Swift & Company's research staff were announced by Dr. H. E. Robinson, vice president in charge of research. **Dr. John F. Murphy** has been named director of laboratories and **Dr. Walter M. Urbain,** director of engineering research.

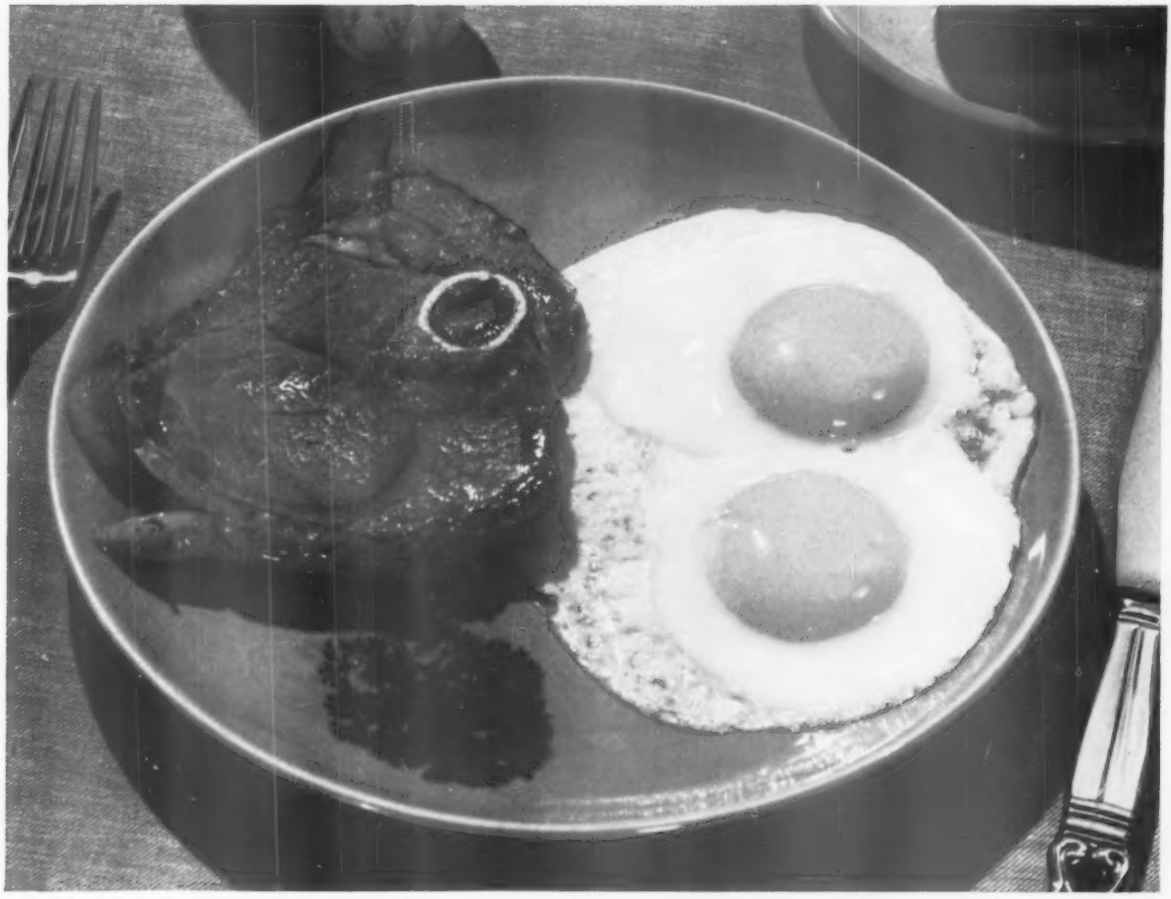
Dr. Murphy, Swift's new director of laboratories, joined the staff in 1953 as research microbiologist. In 1955 he was named head of the poultry research division and during the last year has served as assistant to the director of laboratories. Following his graduation from Georgetown University, he did graduate work in bacteriology and biochemistry at Pennsylvania State University, receiving his master's degree in 1951 and his doctor's degree in 1953.

J. F. Murphy

W. M. Urbain

Dr. Urbain, who received his bachelor's and doctor's degrees from the University of Chicago, joined the Swift research staff in 1933. Successively he has held positions of research chemist, head of the physics and physical chemistry division, and associate director of research. As director of engineering research he will supervise the company's extensive development work in automated processing methods. This is a newly created post.

Dr. Earl Auerbach has been named chief of the division of histology of the American Meat Institute Foundation, not-for-profit research institution at the University of Chicago, it is announced by Dr. Bernard S. Schweigert, AMIF



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director of research and education. The appointment became effective March 1.

August B. Habighurst, 55 Jennings Avenue, Patchogue, Long Island, New York, has been promoted to Group Leader in the Industrial Products Laboratory of the National Dairy research center in Oakdale, Long Island, New York, it was announced today by C. W. Kaufman, Director of Research and Development. Habighurst joined the company in 1942 as an Assistant Scientist and has recently been working as a Food Technologist. He is an active member of the Institute of Food Technologists, in both the National and New York local chapter.

A. B. Habighurst

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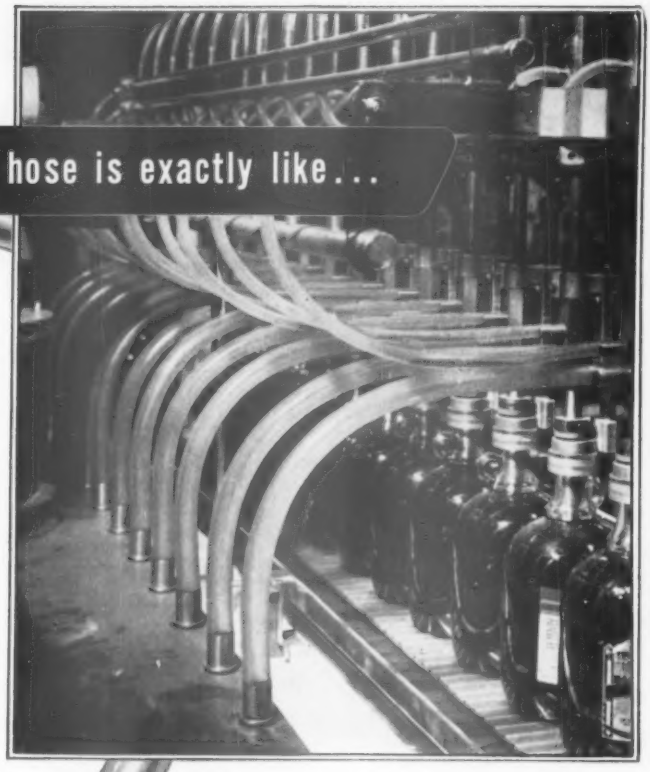

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